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CONTENTS

PAGE

A Symposium on the Classification of Educational Research
John C. Almack, Fred C. Ayer, J. F. Dashiell, Arthur I. Gates, Carter V. Good, Palmer O. Johnson, Truman L. Kelley, William A. McCall, G. M. Ruch, Percival M. Symonds, Herbert A. Toops, M. R. Trabue, F. L. Whitney, Clifford Woody, William H. Kilpatrick, V. A. C. Henmon, Frank N. Freeman, and A. S. Barr 353

Simplified Methods for Computing Regression Coefficients and Partial and Multiple Correlations
Charles C. Peters and *Elizabeth C. Wykes* 383

An Evaluation of Graduate Teacher Training Programs
J. M. Hughes and *E. O. Melby* 394

Economy of Time in College Instruction *George W. Hartmann* 404

Shorter Articles 410

Editorials 417

Reviews 419

Research Abstracts and Bibliographies 426

Research News and Communications 432

THE JOURNAL OF EDUCATIONAL RESEARCH is indexed in the Education Index

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JOURNAL *of* EDUCATIONAL RESEARCH

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A SYMPOSIUM ON THE CLASSIFICATION OF EDUCATIONAL RESEARCH

A. S. Barr,

John C. Almack, Fred C. Ayer, J. F. Dashiell, Arthur I. Gates, Carter V. Good, Palmer O. Johnson, Truman L. Kelley, William A. McCall, G. M. Ruch, Percival M. Symonds, Herbert A. Toops, M. R. Trabue, F. L. Whitney, and Clifford Woody

Critics: William H. Kilpatrick, V. A. C. Henmon, and Frank N. Freeman

A perusal of the literature dealing with the methodology of educational research leaves one with the impression that there is considerable confusion about the meaning, terminology, and classification of research in education. This confusion appears to develop from three conditions: (1) disagreement as to the scope of such expressions as research, scientific, experimental, etc. One frequently reads, for example, that there are four types of research: (a) the philosophical, (b) the scientific, (c) the historical, and (d) the statistical. Are the historical, philosophical, and statistical methods of research scientific? Is there is a historical method of research? A philosophical? A statistical? Is the statistical method a method of research or a method of analyzing data applicable to several types of research? etc. (2) the use of the name of a phase or part of the research process to describe the total activity: *e.g.*, descriptive, causal, analytical, questionnaire, etc. (3) the failure to indicate clearly the point of view from which classifications are made. Methods of research may be classified from an infinite number of points of view, as, for example, from the point of view of the fields to which it is applied: education, history, philosophy, psychology, biology, etc.; from the point of view of purpose: description, prediction, determination of causes, determination of status, etc.; from the point of view of the place where it is conducted: in the field or in the laboratory; from the point of view of its application: pure research or applied research; from the point of view of the data-gathering devices employed: tests, rating scales, questionnaires, etc.; from the point of view of the character of the data collected: objective, subjective, quan-

titative, qualitative, etc.; from the point of view of the symbols employed in recording, describing or treating results: mathematical symbols, language symbols; from the point of the view of the forms of thinking: deductive, inductive, etc.; from the point of view of the control of factors: controlled and uncontrolled experimentation; from the point of view of the methods employed in establishing causal relationship: agreement, difference, residues, and concomitant variation. Where there is a shifting of the point of view in a given classification, without warning or explanation, the result is almost always confusing, producing a result similar to that of a shelf of books classified from a number of points of view simultaneously: color, size, cost, title, etc.

While the problem here described is primarily one of terminology, it is nevertheless an exceedingly important matter, especially when one wishes to describe the procedures pursued in one's own investigations or wishes to give systematic instruction in the methodology of research. The individuals participating in this symposium have been asked to discuss the classification of educational research and to offer what appears to them to be a defensible classification of research methods.

The Symposium was prepared in the following manner: (1) Certain individuals, namely, John C. Almack, Fred C. Ayer, J. F. Dashiell, Arthur I. Gates, Carter V. Good, Palmer O. Johnson, Truman L. Kelley, William A. McCall, G. M. Ruch, Percival M. Symonds, Herbert A. Toops, M. R. Trabue, F. L. Whitney, and Clifford Woody, were asked to prepare independent statements upon the classification of research. After these preliminary statements were received in the writer's office, they were mimeographed and returned to the authors with the request that they be carefully re-read and revised in light of the statements from the other participants in the Symposium. (2) The revised statements were placed in the hands of three critics, namely, Henmon, Kilpatrick, and Freeman. These critics were asked to prepare brief critical comments on the discussion as a whole. The writer stated the problem, prepared the introductory statements, and wrote the summary.

JOHN C. ALMACK

Outline—

I. Scientific Method—Steps in
   1. Introductory phases
   2. Selection of sources
   3. Application of techniques

4. Use of devices
5. Generalization—types of results
6. Verification

II. Introductory activities
1. Summary of history of problem
2. Present interest in problem—reasons for and extent of
3. Statement of problem
4. Analysis and definition
5. Hypothesis stated
6. Sources described and evaluated
7. Techniques described
8. Devices described if necessary

III. Sources of data—types of
1. Documentary—data of record
2. Experimental—data of controlled observation
3. Natural experiment—data of fact

IV. Techniques of research.
1. Historical—applied to documents
2. Normative—applied to data of record
3. Experimental—applied to experiment
4. Conceptual or classificatory—applied to natural experiment

V. Devices of research
1. Statistical
2. Record forms—i.e., questionnaire
3. Calculating machines
4. Charts—i.e., correlation
5. Instuments of precision

VI. Generalization
A. Related to techniques
1. History
2. Law
3. Norms
4. Concepts and classes (This is of doubtful value)
B. Related to objectives (Subjects)
1. Chemistry
2. Physics
3. Biology
4. Geology
5. Astronomy
6. Sociology
7. Economics
8. Political Science
9. History

VII. Verification
1. Re-check and addition of more data if necessary
2. Application

VIII. Final result: *truth tested and put in order.*

Results—

Science is the objective of research. Truth is a synonym of science. According to David Starr Jordan, science is "Truth tested and put in order." In its ultimate form, science consists of generalizations, which are also occasionally called principles. Science is built up of units variously called facts, data, observations, and phenomena. The derivation of data is one of the most important phases of the research process. If the resulting generalization is limited only to the data collected by the investigator it is empirical. If it is always and everywhere true, it is universal.

All true research is carried on by scientific method. It begins with a problem, and from thence passes to hypothesis. The latter is a tentative solution, or assumption of a generalization which subsumes the data. The next step is to discover the sources and from them derive the facts. The sources and the data must be considered critically. "Are they valid?" "Are they reliable?" are the two important questions to ask. The data at hand are generalized. If the hypothesis is a true one, this generalization consists in its re-statement, together with any limiting or qualifying elements necessary.

Sources of data may be classified as (1) historical, (2) experimental, and (3) natural. The sources of history are documents, or what one may call *data of record.* Experimental data result from controlled experiment: the scientific method *par excellence.* Data of fact result from natural experiment: that is, from observations of nature as it is, without modifying it in any way. Geology and astronomy consist almost wholly of principles based upon natural experiment.

After the sources are determined upon, the next step is to apply research techniques. Historical techniques are applied to documents. They consist of criticism of sources, the taking of notes, the making of citations, and the construction of bibliography. Normative techniques are applied to other *data of record:* for example, financial reports. The experimental technique is applied to experiment. The conceptual or classificatory technique is sometimes applied to natural experiment, but probably one should as well hold that, except for control and modification in the subjects, natural experiment does not differ in technique from controlled experiment.

In using techniques, the research specialist employs many *devices.* He finds a marked advantage in using *instruments of precision,* which is equivalent to saying that he measures accurately, and in standard

units; and that he uses instruments which aid the senses: for example, microscopes and telescopes. Other devices are *statistical; record forms,* as the questionnaire; *calculating machines,* and *charts: i.e.,* correlation. These devices may or may not be indispensable depending upon the degree of accuracy and validity desired in the results. In general, one may say, they are, or some are, indispensable to the highest type of research. Calculating machines make for accuracy, and economize time. They represent *transfer of skill* to an unvarying automaton. Another type: *i.e., statistics,* aids materially in reaching the correct generalization.

Generalizations may be put into a two-fold classification. First, they may be grouped according to the *techniques* by which they were derived. History results from the employment of historical techniques, norms from normative techniques, and laws from experimental techniques. Second, they may be grouped according to their objectives, or perhaps, more truly, according to the particular sources from which the data come. Thus we have chemistry, physics, biology, geology, astronomy, sociology, economics, political science, and history.

Finally, the research specialist is under necessity of *verifying* his results. This term is used with two different meanings. Some research specialists consider verification complete, when they have re-evaluated their sources and rechecked their data. Some consider verification complete when they have established *adequate reliability* to their findings. Others consider that the ultimate test is use. "Will it work? Would I trust my life to it?" are the questions they must answer in the affirmative before their task is done. The last (the test of use) seems desirable whenever possible.

In a previous classification of results, one may observe that certain subjects such as psychology and anthropology were omitted. They are more highly specialized or rather they are sub-divisions of a more inclusive field. Psychology is a part of the field of biology. It should not in any form be classed as "social science." The science of education is more or less a misnomer. It is properly used to signify all the principles of psychology, biology, sociology, economics, political science, and so forth that are and may be applied in teaching and administration.

The writer cannot agree that there is a philosophical method or technique of research. Looked at from any point of view, nothing is more certain than *philosophy is not science,* and therefore, not truth. Truth cannot be discovered by logic. Philosophy as method, plays a part in the research process. It functions in the introductory phase as in defining terms and putting forward an hypothesis. It doubtless functions in the

generalizing process, and most certainly, in that important step in which the generalization we have discovered is related to all other generalizations and accurately and systematically classified.

The term "administrative research" often causes confusion. To illustrate its meaning: suppose an administrator wants to apply the principle of homogeneous grouping to the pupils of his school. He needs to know the facts of intelligence, achievement, age, etc. of every child. The gathering of these facts is exactly the same as gathering facts from which to make a generalization. There are differences, however. In the first instance, that is, in *true research*, he advances an hypothesis, collects facts, and generalizes. In the second instance, *administrative research*, he advances no hypothesis and forms no conclusion. He uses a principle already derived. He applies it to individuals, and by its guidance rearranges his classification. The term "research" should not be applied to this kind of activity, even if it is fact-gathering. Taking a lesson from the army and navy, we might call such activity "making an estimate of the situation," or survey.

Administrative research may be used with another meaning, that is, to signify the use of scientific method to the solution of an administrative problem. The problem may have been detected as a weakness in the school. The resulting principle may always be classified as belonging to one of the basic sciences. Charters wisely uses the term "applied research" to stand for the solution of a problem existing as a weakness in a going concern. This is a different thing from making use of a principle already derived. Both cannot be called "applied research." In making use of a law or norm, there is often a choice of several techniques. The making of a technique is not research. It may more properly be called invention, though it is doubtless better to restrict this term to a device or mechanism for the original use of a principle or combination of principles.

Mathematics doubtless belongs either with techniques or devices. So far as the writer knows, there has been no clear-cut plan evolved for making new techniques. The devising of standard tests, job-analysis, time-and-motion studies come as near to offering systematic procedures as anything. In making the power loom, Cartwright turned to account his observations that weaving consisted of three acts, in one, two, three order. A sequence of things to do, with a known time duration for each act, are the essential elements in technique.

To summarize, research is the process by which truth is discovered. It can never be anything else but scientific; there is but one method.

The technique to employ depends upon the nature of the sources, and the sources depend upon the problem. Reliability, validity, and originality are increased by the use of *primary* sources. Instruments of precision and other devices extend the observations, add to their accuracy, and save time and effort. The results of research may be classified as history, law, norms, and concepts (or classes); and should be related to other similar principles in biology, sociology, chemistry, or other fields. Finally, the results should be checked and applied. When scientific method has been properly carried out, we have "truth tested and put in order." This is the real objective of research.

FRED C. AYER

The meaning of research may be broadened or narrowed to suit the purpose of the author. Research methods have been classified very broadly as historical, philosophical, and scientific; as pure and applied; and as individual and coöperative. All of these subordinate fields reveal new lines of cleavage according to the type of materials or data involved, the immediate or ultimate purpose of the research in question, and the availability of reliable techniques. Methods of historical research, for example, differ widely from those of biological research, and so also the standards acceptable in meeting the requirements of a Ph. D. degree vary distinctly from those which characterize research in the industrial world.

Research, and particularly scientific research, is usually held to involve the orderly discovery of something new, but to discover new facts in most fields of knowledge is relatively simple; to discover new principles is always a matter of difficulty. The concept of orderly discovery limits the general character of research, but places little restriction on its special methods. These have grown so rapidly with the advent of modern science that there are few at present who can claim familiarity with the methods of research in more than a few of the numerous fields.

It is greatly to be doubted if it is practicable to reduce research in its present complex and specialized status to a set of universal procedures. To do this smacks a good deal of faculty psychology, and the five formal steps in lesson planning. Methods thus formalized are as likely to do as much harm in suppressing originality and stifling new techniques as they do good otherwise.

The present writer will, therefore, confine his discussion to a single field, namely, research in public school administration.

Educational administration, inasmuch as it has a definite program of activities to carry out, leans toward the practical rather than the pure aspects of research. The public school program is to a large extent one of common purposes and similar practices. For this reason administrative research tends to be cumulative and coöperative rather than disparate and individual. Two systems of classification may be applied to the methods of administrative research: (1) According to the subject matter or field of investigation; and (2) According to the phase of research activity.

I. Methods of Administrative Research According to the Field of Investigation

Each of the fifteen fields of administrative research listed below has developed a series of norms, devices, and techniques peculiar to itself and which in many cases are totally distinct from those used in the other fields. Limitations of space prevent detailed discussion of these different methods. They are, however, familiar to those who are at all conversant with the general field of educational research. The several fields below are ranked according to the amount of advance made in administrative research, based on the combined judgment of forty-one city school superintendents and professors of educational administration.[1]

1. Educational measurements
2. School surveys
3. School buildings
4. The curriculum
5. Administrative organization
6. School finance
7. Instruction
8. School equipment
9. Extracurricular activities
10. Child accounting
11. Educational publicity
12. Supervision
13. Personnel management
14. School law
15. Duty and job analysis.

[1] Ayer, Fred C. "Administrative Research in Public School Administration," *The Nation's Schools*, September, 1928. p. 14.

II. Methods of Administrative Research According to the Phase of Research Activity

There are four chief general phases of administrative research: (1) analysis, (2) refinement of instruments, (3) experimentation, and (4) practical application. Each of these will be characterized briefly.

(1) *Analysis.* This includes the discovery and description of factual materials, the assemblage and statistical treatment of data, the proper isolation and orientation of contributing factors, and the setting-up of pertinent administrative problems.

(2) *Refinement of instruments.* This embraces the development of the quantitative concepts, measuring units, standardized norms, statistical procedures, and research techniques that are essential to more rigid experimentation and evaluation of administrative practices.

(3) *Experimentation.* This includes the application of the methods of scientific experimentation to the variable factors in educational administration.

(4) *Practical application.* This refers to the interpretation and evaluation of the results of laboratory and other isolated or outside research and their application to local classroom, school, and community educational situations.

To these might well be added a fifth, *dissemination,* because the present practice of making the results and techniques of research available to others through literary treatment, publication, criticism by committees, reports before learned societies, classroom instruction, and other means of dissemination plays no small part in the present advance of scientific discovery.

J. F. Dashiell

An accurate and complete body of facts involves:

I. *Direct observational* (other than experimental)
   (a) of *materia in situ*
      e.g., astronomical, geological, anthropological.
   (b) of *materia* isolated, e.g., botanical, zoological, anatomical, clinical.

II. *Experimental:* artificial control and manipulation of factors involved
   (a) of *materia in situ*, e.g., economic, entomological.
   (b) of *materia* isolated, e.g., physical, chemical, psychological.

III. *Survey:* collecting of data bearing on *materia* (contemporary)
   (a) obtained from documents and other available data—sources, e.g., legal, sociological, economic, fact-finding commissions.

(b), obtained from questionnaires returned, e.g., sociological, educational.

IV. *Historical:* examination of library and museum collections.
  (a) archives, e.g., historical, archeological.
  (b) specimens, e.g., geological, anthropological.

V. *Speculative*
  (a) abstractions as *materia,* e.g., metaphysics.
  (b) non-content *materia,* e.g., mathematics, logic.

(*Statistical* ancillary to most above-mentioned: not a type of research, but a tool.)

INTERPRETATION

All research is motivated by a fact-finding intent, regardless of a divergency of particular methods and technique. Any fact-finding, then, is research in some sense of the word, even the work of a governmental commission, for example. This, I should say, is the important thing, not the methods used; and it is this that distinguishes research from the many other human interests and projects of men. It is contrasted greatly with ethical or religious interests for instance, as these are occupied with the establishing and maintaining of normative standards and values. Aesthetic interests have little or nothing to do with the factual point of view, for it is frequently irrelevant whether that which is contemplated as beautiful is a matter of real existence or only "a figment of the imagination." Statecraft and public welfare, though dependent eventually upon an informed knowledge, are still motivated by an interest in so organizing and reorganizing social life in some of its phases as to make for more ideal conditions in some sense of the term.

All of these other human interests seem to have—in varying degrees and in strikingly different directions—as their ultimate objective the realization and control of human *values.* True research, on the other hand, is not done in the spirit of wanting to learn what is "best" in any sense of the word, but only what "is." To be sure, all interests in facts-for-facts'-sake get their primary drive from the interest in values; but, as a mode of thinking, if research is to be valuable, it must be pursued in an objective, impersonal, non-evaluational manner.

ARTHUR I. GATES

The list includes representative tests or devices which are used in various degrees by scientists, philosophers, historians, statisticians, and others engaged in the pursuit of truth. It does not pretend to be a complete list.

I. Methods of Determining Validity of Facts Previously Reported.
   1. Tests of validity of report by determining the consistency of its detail, e.g., testing consistency of language, style, references, etc., in a historical document.
   2. Tests of validity of a report by comparing it with others, e.g., comparison of recorded documentary reports of several observers.

II. Methods of Securing Valid Data by Means of Observation of a Present Event.
   1. Testing the reliability and competence of an individual observer.
   2. Testing the reliability of a report by observing its internal consistency.
   3. Examining the degree to which influential variables are controlled.
   4. Repeating an observation under identical conditions.
   5. Using mechanical aids, such as microscopes, photographs, etc.
   6. Using quantitative methods, such as clocks, intelligence tests, etc.

III. Methods of Securing Valid Conclusions or Generalizations or Principles.
   1. Applying rules of formal logic.
   2. Applying rules of science, such as the principle of parsimony.
   3. Applying principles of mathematics and statistics.
   4. Applying pragmatic tests of application, e.g., current tests of the Einstein theory.

DISCUSSION

The outline is based on the belief that the various "types" of pursuit of the truth as represented in the work of the physicist, anthropologist, psychologist, historian, philosopher, physician, mathematician, statistician, etc., are not entirely different, but overlapping. To the extent that their work is valid, all use more or less the same basal principles. The basal principles of scientific, philosophic, historical and other forms of research are, in fact, merely the best methods of securing reliable observations (or raw facts or data) on the one hand, and of drawing conclusions (or generalizations, theories, principles, laws, etc.) from them, on the other. Any one investigator may utilize all of the particular devices or specialize in the use of several.

Thus the work of the scientist, philosopher, historian, anthropologist, etc. differs chiefly in the emphasis given to the various particular procedures listed in the outline. The philosopher, for example, may specialize in "generalizing" (Part III, above) and do least work with experimenting with raw data (Part II, 4, 5, 6), although doubtless utilizing

more or less the methods outlined under Part I. A psychologist or other scientist would normally make more extensive use of the procedures in Part II; a historian those in Part I, although both would use those in Part III.

In general, then, I believe that there is a common tendency unduly to *contrast* the methods of such specialists. I believe it would be more wholesome to emphasize the common functions and interdependencies among them. We ought to consider our work as a coöperative enterprise pursued by specialists, rather than a number of independent and competing pursuits. No one type of study can exhaust all sources of information essential to the solution of educational problems.

CARTER V. GOOD

Research is simply a carefully planned, intensive search for previously undiscovered truths which may be formulated in terms of fundamental generalizations. The steps in educational research are the same as for critical, reflective thinking in any field of intellectual activity: (1) the formulation and definition of the problem, (2) the collection and assembly of necessary and relevant information or data, (3) critical analysis of the data, (4) the development and formulation of hypotheses or possible solutions, and (5) testing the validity of the proposed hypotheses until a satisfactory solution is found.

In the collection, analysis, and testing of data to determine truth, investigators employ a variety of procedures. Because of the number and diversity of these approaches to truth and due to the varying terminology employed, many educational workers have prepared convenient classifications of types, methods, or techniques of research. It seems advantageous to have such classifications available for the student of educational research, especially the beginner, although it should be kept in mind that all fundamental research has in common the goal of truth and the elements of critical reflective thinking previously enumerated.

The writer has employed eight subdivisions in a classification of techniques of educational research with no attempt at sharp demarcation between what may be considered by some as fundamental methods, minor techniques, and devices. Under the direction of an expert, what was a minor technique in the hands of a beginner may become a major procedure in the approach to truth, for example, the case study. Therefore, the present arrangement is intended as a working classification of the

various methods or techniques of collecting educational data. It is recognized that these procedures vary in value as research techniques in the hands of different educational workers and in a diversity of situations.

1. *Historical, Legal, Bibliographical, and Summary Techniques.*—The historical method is considered a major approach to educational truth. Much of the earlier emphasis on historical research has been diverted to the study of legal aspects of education, including statutes and court decisions. Both historical and legal research involve painstaking examination of original sources and documentary study. The work of Professor Edwards and his students at the University of Chicago is especially well known in the field of legal research in education. Of late, valuable educational summaries such as those of Gray in reading, Buswell in arithmetic, Lyman in language, grammar and composition, and Curtis in science, have appeared. Critical summaries require research ability of high order in the work of analysis and synthesis required, and are among the most valuable contributions to educational literature.

2. *Experimental, Laboratory, and Controlled-Observation Techniques.*—The experimental method also is considered one of two or three major types of educational research. Experimental and laboratory techniques have possibilities for solution of numerous and significant learning and teaching problems. Of course the greatest difficulty in using these methods is in controlling variable factors. Group methods of experimentation are one-group; equivalent or parallel-group, and rotation-group are the others. Outstanding examples of experimental and laboratory procedures are the Chicago reading studies, which have utilized the eye-movement technique, and the nature-nurture yearbook (1928) of the National Society for the Study of Education.

3. *Survey, Comparative, and Descriptive Techniques.*—The school-survey technique usually includes other methods of research such as questionnaire, statistical, testing, historical, or philosophical. However, it is a type of investigation for which a number of specialized procedures have been developed for making comparisons between periods in history, nations, regions, states, counties, cities, districts, schools, grades, departments, subjects, school enterprises, etc. As such it seems to merit mention as a definitely established research technique. The national surveys of secondary education and teacher training, the Modern Foreign Language Study, the Educational Finance Inquiry, and the educational yearbooks of the International Institute of Teachers College, Columbia University, are good examples of this technique.

4. *Questionnaire, Check-List, Rating-Scale, and Interview Techniques.*—The questionnaire method is a useful, if overworked and abused, device for securing educational data. The interview is an oral-questionnaire technique. Check-lists and rating-scales are forms of the questionnaire.

5. *Statistical, Mathematical, Testing, and Test-Construction Techniques.*—The statistical method may be considered as a way of manipulating data rather than as a technique for securing new information. Of course there are a few pieces of research in which new formulas or statistical devices are worked out. Test-construction and testing studies utilize extensively the available statistical tools of central tendency, variability, reliability, validity, and relationship.

6. *Analysis (Activity, Job, Social Need or Usage, Books, Courses of Study, Difficulties, Etc.) Techniques.*—Activity or job analysis as a technique has been borrowed from the industrial world to aid in determining what activities to emphasize most profitably in the school. It has been applied frequently in analyzing social need or usage as a guide in curriculum reorganization. The work of Charters, Bobbitt, and their students is especially well known in this type of research.

7. *Case-Study, Case-Group, and Genetic Techniques.*—The case method has been borrowed from medicine, law, social service, and military science, and applied in education to problems of abnormality, brightness, dullness, adjustment, adolescence, problem children, special talents and defects, mental and physical growth, etc. Authors of educational textbooks recently have utilized this principle in the organization of subject matter. Illustrations of this technique may be found in the Stanford *Genetic Studies of Genius.*

8. *Philosophical, Subjective, and Committee-Judgment Techniques.*—Many students of objective methods in educational research will not concede the existence of a philosophical technique of investigation. However, it is to rationalization that one must turn in the interpretation of data and in determining ultimate goals and values. Even though this technique of thinking will not be accepted in all quarters as a type of research it must be admitted that important contributions to educational literature have been made by the use of procedures of a subjective nature, for example, Dewey's *How We Think.* The 1926 yearbook committee of the National Society for the Study of Education agreed on fifty-eight statements which were considered expressive of the best available principles for taking the next forward steps in curriculum making.

PALMER O. JOHNSON

A. Documentary analysis
   1. Historical
   2. Legal
      a. Statutes
      b. Decisions
   3. Courses of study
   4. Records and reports
      a. Institutional
      b. State
      c. Federal
      d. Private foundations
      e. Surveys
      f. Educational associations
      g. Foreign school systems
   5. Textbooks

B. Indirect observation
   1. Check lists
   2. Correspondence
   3. Questionnaires
   4. Rating scales
      a. Graphic
      b. Order of merit ranking
      c. Man-to-man comparison
      d. Paired comparisons
      e. Range of values

C. Direct observation without instrumental control
   1. Ordinary observation
   2. Unstandardized interview

D. Direct observation with instrumental control
   1. Experimental methods
      a. One-group
      b. Equivalent-groups
      c. Rotation
   2. Learning
   3. Physiological
   4. Psycho-physical
   5. Standardized interview
   6. Test methods
   7. Verbal reports

E. Composite methods
   1. Case—method
   2. Case—group method
   3. Activity analysis

4. Job analysis
5. Field studies
6. Survey

The principal concern in the classification of the methods of educational research reported has been with the procedures that may be employed in the gathering of data for the purpose of systematically answering educational questions. The character of the problem determines the nature of the data to be collected, which, in turn, determine the method to be employed in their collection. The method of treatment of the data must be anticipated to some extent, because this partly may affect the method of collection. The method of handling the data, however, has not been made the basis of classification.

The chief basis for the classification is the extent of control exercised by the investigator in the conduct of his investigation, with particular reference to the techniques employed in the collection of data.

In documentary analysis consideration is given to data which have already been accumulated. The investigator has not been instrumental in their collection. Necessarily, selection must be made of sources that furnish data significant to the solution of the problem and the conditions under which the data were collected must be carefully evaluated. Under this category have been placed such sources of data as laws, records, and reports, etc. The historical method may be considered diverse enough to merit an independent category. Consideration in it, however, is given essentially to documentary data.

Under indirect observation, as here defined, the research worker has developed the techniques or instruments of his investigation but, in general, there is an intermediary between him and the subjects, objects, or conditions under investigation. He is observing indirectly conditions through some other agent whose observation he directs, to a certain extent, by the techniques afforded for making the observations. It is to be understood that the uses of the techniques enumerated are not necessarily limited to this particular category.

The distinction between the next two categories (B and C) rests upon the refinement with which observations are made. In direct observation without instrumental control, the investigator may exercise care in the collection of data and use more or less refined methods of treatment, but he has not been instrumental in exercising refined control, over the conditions under which they were collected. In direct observation with instrumental control, the distinguishing character is measured conse-

quences under controlled conditions. This is the sovereign method of research but the ideal conditions are perhaps rarely, if ever, attained in educational experimentation.

There are certain methods of investigation such as the case method, survey, etc., which may be characterized as composite in nature. The case-method, for example, may employ tests and measurements, history, observation, interview, analysis of records, and any other special techniques that may prove of service. Activity analysis may employ the interview, the questionnaire, observation of subjects, analyzing the records of activities performed, or even performance on the part of the investigator.

In conclusion, it may be said that as a practical situation, the investigator feels called upon to employ any or all of the methods or techniques that have been listed, in the attack of many problems. All methods possess limitations. It may be necessary to combine all available methods to insure the most certain approximation to the truth.

TRUMAN L. KELLEY

I make no classification into scientific and non-scientific research. If one wishes a dychotomy, it seems to me that it should be into research accepting and abiding by the best available checks of knowledge for the field in question versus loose thinking endeavors in the same field. If the best available checks are employed, no matter what the field may be, it seems that it should be characterized as scientific. This is really a minor point as the entire matter is one of verbal distinction. For distinctions as to research which I believe are not verbal, I would cite the four following fields.

1. Research in the field of logic, metaphysics, pure mathematics, etc.
2. Research in history.
3. Research in experimental science.
4. Research in forecasting.

It is very valuable to distinguish between these four types because, as I see it, the tests of excellence or of validity are different.

In *1* the test is unity or complete coherence of thought structure.

In *2* there are several tests. They have to do with validity of a unique source of information as well as with the soundness or logic of the argument employed.

In *3* the essential test involves agreement between hypothesis and experience, and the phenomenon is a repetitive one so that it can be checked and re-checked. Statistical checks abound.

In *4* the tests are at present far less well established but they surely depend upon all of the tests called for in 1, 2, and 3, and probably upon other tests as well.

Just as in the first field, logic may be distinguished from pure geometry or number theory, so each of the other fields may be broken up further. I believe, however, that such subdivision involves features of secondary importance to those characterizing the differences between the four fields mentioned.

This classification could be elaborated almost indefinitely. I have treated at some length certain phases of it in my book, *Scientific Method*, and also in my article, "The Scientific versus the Philosophic Approach to the Novem Problem," appearing in *Science*, March 21, 1930, Vol. 71, No. 1838.

WILLIAM A. MCCALL

I. Classification by the place where the research is conducted. Illustrations are:
   (1) Laboratory research
   (2) Field research
   (3) Classroom research

II. Classification by the extent to which the objective of research is to meet some need of man other than curiosity or, stated differently, classification by the expected interval between discovery of truth and its application:
   (1) Pure research
   (2) Applied research

   Research may be located on a continuous scale from very pure to very applied.

III. Classification by the broad fields of knowledge which the research serves. Illustrations are:
   (1) Educational research
   (2) Historical research
   (3) Business research
   (4) Philosophical research
   (5) Scientific research

   Some of these terms, for example, historical research and scientific research, are sometimes used to designate a method as well as a field. The above classification applies only when the terms are used to designate the field of inquiry.

IV. Classification by the narrower fields of knowledge which research serves. Illustrations are:
(1) Instructional research
(2) Pupil accounting research
(3) Curriculum research

V. Classification by the type of findings the research seeks to establish. Illustrations are:
(1) Descriptive, survey, or normative research which aims to describe a situation or individual accurately;
(2) Causal, diagnostic, or prognostic research which aims to secure such a knowledge of causes or influences as will permit prediction;
(3) Policy or program research which aims to formulate a policy or program and generally involves descriptive, causal, and other types of information.

Here again certain of the foregoing terms are used currently in two senses, namely, type of information yielded and method of research employed. For the time being the latter meaning is excluded.

VI. Classification by the research methods or instruments employed. Illustrations are:
(1) One-group experimental method
(2) Equivalent-groups experimental method
(3) Rotation-groups experimental method
(4) Varying-concomitants method
(5) Correlation and partial-correlation method
(6) Causal-investigation method
(7) Case method
(8) Genetic method
(9) Bibliographical method
(10) Comparative method
(11) Analytical method
(12) Statistical method
(13) Questionnaire method
(14) Test method
(15) Rating method
(16) Quantitative method

And many other specialized methods, not mentioned above, usually named for the general field of knowledge where they were first used or are now most used, for example:
(17) Historical methods
(18) Sociological methods
(19) Psycho-physical methods
(20) Scientific methods
(21) Philosophical methods

Which of the above terms and classifications are the best ones? All are needed. If we did not have such a wealth of terminology we would create it to meet a genuine need. Any research may be viewed and often needs to be viewed from the point of view of every classification and most of the terms. This does not mean that I am satisfied with present terminology. The following are a few of my criticisms of it:

1. We have already pointed out that certain terms are used in two or more senses at different times. This sometimes leads to confusion.

2. There is much duplication or overlapping of terms. Thus, *statistical method* and *quantitative method* substantially duplicate each other and both overlap *experimental method.*

3. The more inclusive terms refuse to include all of each of the subordinate terms, thus defying a perfect scheme of classification.

4. Terms are often named for the fields where they first accidentally developed. This tends to increase the friction between specialists in the different fields, and, what is worse, tends to restrict research procedures to the field for which they were named. Thus the term *scientific method* applies to the subordinate term *experimental method* has been responsible for much unnecessary friction between scientists and philosophers, and it has tended to restrict the use of experimental method to the natural sciences; whereas, the method is quite applicable in philosophy, particularly in connection with the philosophy of pragmatism. It is more or less of an accident that scientists were the first to become acutely interested in and to successfully use the experimental method. In view of the greater significance of their problems, theologians, philosophers, sociologists, and politicians might well have been the first to formulate so-called scientific methods.

G. M. RUCH

Research, as the name implies, is *inquiry directed at the discovery of truth.* One test of research is therefore the use of *original sources.* If this point of view is taken, there is but one type of research. Since truth, for present purposes, is empirical truth, not absolute truth, it follows that the results of inquiry into truth may represent varying stages of finality of proof. The ultimate or final test of truth, in the empirical sense, is the statement of the discovery in quantitative form, *i.e.*, as an equation or mathematical law.

Since the discovery of truth must be the outcome of quite different methods in the various fields of knowledge, it may be at times convenient to classify research methods into broad types. Perhaps three such types are useful, viz.:

(1) Historical research
(2) Philosophical research
(3) Scientific research (experimental research).

Some classifications of types of research include "statistical" research; the present classification does not. Statistical method is a powerful tool in both description and inference, but it is not coördinate with the historical, philosophical, and experimental methods since it is properly the ally of all methods.

INTERPRETATION

The confusion as to the exact meaning of the term *research* has arisen with the growth of the exact sciences. Originally a general term for method, the growth of pure science has given it a limited meaning. Modern emphasis on the social subjects demands a return to the broader and earlier definition.

The central and fundamental idea of research is the discovery of *new* truth. The utility of such truth is a secondary consideration. The highest research is, however, more than the discovery of isolated facts. There must be, further, the critical scrutiny of these facts, leading to generalizations and hypotheses. These in turn under further study become theories, and finally laws in exact quantitative form. Mathematical statement of final result is not necessary as a test of research although it is generally conceded that quantification insures objectivity and verifiability.

It is important that we recognize that there must always be certain differences between research methods in the physical and in the organic sciences. The advent of protoplasm introduced a phenomenon hitherto unknown (in the inorganic molecule), viz., *variability*. The final laws of the organic sciences will therefore be characterized as *trends*, best represented by statistical averages, correlations, etc.

Educational research deals with organic phenomena almost exclusively. Moreover it deals with the most complex of the organic phenomena. It is not surprising that educational research is rarely highly exact. Practical needs induce approximate results and many educational practices cannot await remote final answers. It is to be regretted that educational research workers do not always observe the distinction be-

tween opinion and truth. No matter how useful a consensus of opinion may be, such an assembly of opinion is not to be confused with demonstrated fact although weight of opinion *may* at times approximate empirical truth.

PERCIVAL M. SYMONDS

The meaning of research in education is vague, more vague in fact than it was a few years ago due to extensions of the meaning of the term. It is at once recognized that it has to do with the new, the unknown. Research is a term to conjure with, and its significance has been so magnified that students of education feel that it transcends in importance all other phases of their training. The lady who said that she was going to the library to do some research when she merely meant that she was planning to read a book, exemplifies the importance that has been attached to this term in current thinking. The discovery of existing facts and relationships has been the traditional meaning of research in education, but more recently the invention of new procedures, new methods, and new devices in education has also been termed research.

Recent emphasis has been placed upon experimentation as a method of educational progress and social reconstruction. By this is meant the trying out of new educational procedures and methods and new social customs and institutions with the hope that their value can be ascertained by actual trial. In this sense the work of the experimental school may be termed research. This, however, is not the customary use of the term which has been largely confined to methods of testing and observation. The distinction between *invention* (of new methods and devices) and *discovery* (of existing facts and relationships) is pertinent here. Both refer to making the unknown known and the unsolved solved. Strictly speaking, these attempts to do the original should not be called research until the outcomes are tested against recognized criteria.

Several years ago, in analyzing current research as found in doctors' dissertations in education, I discovered that research is nothing more than straight hard thinking or problem solving in a given field, making use of the instruments and methodology which has been found necessary to provide the necessary controls and checks on the results.

In research the emphasis should be given to facts, data, experience, and the recording of observations. In this sense philosophical research is an

absurdity. That which one spins out of his own reflections sitting by the open fire, or even discussing his ideas and points of view in a group, cannot be dignified by the term research. Research must be on the past or the present, it cannot be on the future. Research can not be expected to answer the questions, "what should be done?", "how should this be done?", or "when should this be done?". These are matters for judgment and decision. The findings of research help make such decisions more intelligent and rational. Making a decision is a different type of mental operation than from acquiring facts.

The customary classifications of research techniques into types of research overemphasize differences which are matters of relative emphasis only. In certain cases the whole investigation comprises a resume and evaluation of past events, and we have historical research. Even in an experimental inquiry, however, one should precede his work by knowing what others have done in the past on the same topic or in the same field. Again all research should include statistical methods, although at times this use of statistics may be exceedingly elementary and simple. In historical study, however, which should seem to be as far removed from the statistical as possible one should not draw conclusions on the basis of a single event. For example, one should not draw conclusions as to the nature of the academy in the eighteenth century from the description of one such academy. The question of sampling arises wherever generalizations are to be made and sampling is a statistical issue.

Methods of Research:

A. Historical
B. Descriptive survey
C. Analytical survey
D. Discovering relationships
E. Experimentation
F. Development of techniques

The present classification of research procedures is given for what it is worth. It is a classification based on the distinction between the simple and the complex, or between the specific and the general. First, there is the historical research which involves in its simplest aspects a description of past events and phenomena. In the descriptive survey one merely describes a specific situation in the present, as when one surveys a school system or describes a textbook or rates an individual. By analytical survey is meant that type of survey in which more general facts are collected, as when one undertakes vocabulary inventories or error analyses

or survey of interests or abilities of individuals. In this analytical study the description of what is found in a fraction of the population is assumed to be representative of the whole population and attention must be paid to the representativeness of the sampling. In the third type—discovery of relationships—one is concerned with the static study of relationships as evidenced by the familiar correlation study. In experimentation, however, one is concerned with dynamic relationships. Experimentation hopes to expose cause and effect relationships or the influence of one phenomenon on another.

Finally, in the development of new techniques, whether in the development of new instruments of measurement, statistical methods of interpreting data, or methods of collecting data, one reaches the research activities requiring the highest degree of ability and sagacity.

This classification is by no means the only classification possible, but represents one way of looking at the differences in research methods as varying from those having particular reference to those with reference that is more general and universal.

HERBERT A. TOOPS

I do not know enough about the classification of the methods of research to make a contribution. Classification itself seems to me somewhat futile when classification of and training in the uses of the tools of research is so sorely needed. I am, however, taking the opportunity of making a few comments:

1. I think that it is true that the research worker nearly always has a hunch from the outset as to the outcomes of his study. In other words, the notion that the scientist reasons "by cold logic," assisted by precise data, to his conclusions from a set of fundamental premises is pure bunk. He often derives his premises for purposes of publication. He often "reasons" first and deduces his logic afterwards. Hence we may at once dogmatically assert that there is no valid distinction between "scientific" and "unscientific" thinking; and no sharp distinction between "scientific" and "unscientific" methods of research. A research should be measured by its products; and not by its method of attainment. Science is a very human "trial and errors" process. The truth which it aims to discover is relative to the times, and changes as rapidly as its acknowledged experts change their thinking. Scientists, theoretically, differ from

ordinary men in being more willing to admit new evidence and less willing to discard old generalizations which work than the new.

2. All research—all adequate research—attempts to lay down principles (therefore is *causal* in a certain sense); and in the future, that which may adequately be called research, in increasing proportions will attempt to set up the means whereby it may become *predictive*. Prediction, actual or potential, is the only necessary criterion of what is scientific. Distinctions of "pure" and "applied" science are groundless, and scientifically a debit rather than an asset.

The predictive aim of the physical sciences is self evident, as is also the case in forecasting, intelligence testing, and measuring of growth and attainment. The equations of all of these are a means of excluding judgment as to what-will-happen, and so of standardizing observers reactions to the situations in which the equations are involved.

This standardization of observers' responses is no less the aim of descriptive science, which is an early stage of prediction and always therefore in the birth throes of becoming predictive.

A dichotomy into quantitative methods and descriptive methods seems reasonable; yet, as shown below, the two kinds may be unified. To set up a definition—a class name, for example—is, as will be shown below, to set up an implied equation, whereby say 99.99 percent of competent persons subsequently will correctly identify, *and act the same towards* the given thing so classified. That is, we seek to establish a name such that we can *predict* what *trained* people will do with respect to the thing in question. Hence science exists not so much in its methods, its tools, or even its results as in the standardization of training and modes of response of its accepted experts. Alchemy was an acceptable science at one stage of civilization, but it lost its following with increasing inability to meet the successively imposed tests of the acknowledged experts. It is not too far from the truth to say that what to-day is scientific can be decided by a vote of the acknowledged experts in positions of authority.

WHERE CASE WORK AND STATISTICS MEET

The aim of the correlational statistics (that of the physicists is of this sort) is to establish an equation that seeks to pre-determine the quantitative predictional measure of the behavior of the individual or thing in question. The aim of the individual or case method as of all descriptive research is to establish an unique equation of each individual such that his or its *status* is uniquely determined. In the former case

we are interested in an equation of maximal correlation, in the latter of minimal correlation.

The literature is full of illustrations of attempts to establish the former type of equation: scales, score cards, test batteries, the prediction of stock market prices, and growth curves. The statistics of the latter is but little developed, and has not yet any generally accepted name.

The case of the botany key is an illustration of the point in question. Let us say that we have an object in hand which, without being botanists, we are astute enough (trained enough) to rightly place in the category of "plant." Now if we have a modicum of training we shall be able to distinguish whether the leaves of the plant (implying that the leaves are at hand for first hand observation) are "parallel veined" or "net veined." Having correctly made this important decision, we at once reduce the probability, if it be adjudged net veined, that the plant is a "lily" or an "onion" or an "iris" to substantially zero.

In general we reduce to zero the probability of ascribing to this particular individual plant the class name of any of the plants that are parallel veined, thereby excluding, let us say, some 25 percent of all of the possible competitors for names. In symbols the uniqueness of the plant is now represented by the following formula:

$$U = 10^{(n-1)}V_1 \qquad (1)$$

Where n = any power, its size being the number of factors, n, required to establish complete identity of the plant (at the present stage of knowledge);

U is the uniqueness index, which becomes unique ("never duplicated") when enough positively identifiable traits are discovered and included in the equation.

V_1 = a code number assigned for the rating of the plant in the categorical class just determined; say, 1 for net-veined; 2 for parallel veined.

Let us now make another determination of some characteristic of the plant, particularly one in which exists a great many categories (preferably equally frequent; *i.e.*, rectangular distribution) of an absolutely identifiable characteristic. The equation now is:

$$U^{*} = 10^{(n-1)}V_1 + 10^{(n-2)}V_2 \qquad (2)$$

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*We assume that the code numbers in no case exceed one digit in size; if they do, then the exponent decreases in direct proportion to the maximal possible number of coded categories of the trait in question.

If the correlation, or association, between Trait 1 and Trait 2 be zero, U will be more variable, considering the whole world of plants, than if the traits be not independent.

The ultimate aim is to establish a code number for the plant which shall: (1) be a portrayal of its characteristics; (2) be unique, *i.e.*, never apply to two "different" plants; (3) increase the variability of all U s existing in the universe. Each such addition of a trait complicates the uniqueness index still further, until ultimately we get to a point where there is only one plant answering the description. The final formula is:

$$U = 10^{(n-1)}V_1 + 10^{(n-2)}V_2 + \ldots + 10^{(n-r)}V_r \quad (3)$$

Practical considerations require that the traits be added in such an order that (1) a minimum of mistakes in classification shall result in the use of the final key *by those who will use it most frequently;* (2) and that, other things being equal, the correct class name shall be arrived at with a minimum of effort. Only the first of these is a criterion of scientificness (as yet); while the second, distinguishes the research as one of applied science or one of pure science. Pure science is willing to say, "The job is done" just as soon as the eggs are hatched. "What matter to us how the chicks grow up, or whether they grow up at all. We have more important (to us) things to do!" Both pure research and descriptive research are underdone pancakes—promises of a worthy meal, but bad, in their present state, for the digestion.

As soon as the equation of the plant is at hand, the following dogmatic statements may be made:

(1) *To date,* there is only one plant answering the final description.

(2) If there are still additional characters, by adding these as characteristics of our description we may still further decrease the probability that any other plant will ever get into the compound category just now accorded this particular plant.

(3) If, through exploration or otherwise, a number of plants answering the description to date should be discovered, it will be necessary to find additional characters in order to differentiate the additional plants from our present one, for otherwise, a discrimination cannot be made, and unless a discrimination is made the new plants are not recognized as a distinct species but are considered to be the same as the old. When "new" plants are discovered the uniqueness index must either be lengthened in size or the whole scheme be recast on a new basis. It is obvious

that the larger the number of uncorrelated factors which enter our uniqueness index, the longer the classification will endure.

(4) Historically, many plants have been in the status of indetermination and have received new names as soon as an additional "variety" was found.

(5) Historically, the classifications of botany, zoology, and what not, have had to be revised many times for the simple reason that they did not take account of the statistical requirements that the probability of the frequency of the individual U should be made as near infinitesimal as possible in order to provide for indefinite expansion of the system in the future.

(6) By an indefinite expansion of the traits involved in U, we arrive, in humanity, at the generalization that "no two individuals are alike." Reactionaries—and a few misguided progressives—exploit this generalization to the utmost.

(7) We have arrived at a number, or formula, sufficiently unique to set our plant off from all others, *now known*. Consequently, we may now uniquely name it, if we choose.

Having received a name, the name is verbal short-hand for the whole host of characters represented in the formula and is simpler to deal with than the formula, which, however, is scientifically more exact, more precise and more useful. The name has a disadvantage in that it is probably only temporarily unique, unless an additional character or two be added after initial uniqueness is attained and be left blank for an indefinite amount of expansion. And, surely I need not dwell on the futility of Latin names!

3. The so-called individual methods, case methods, etc., presuppose a training of the case-worker, an acquirement of "statistical experience" such that he may envision the existence of a predictive equation wherein his judgment allows him to supply the numerical values (so to speak) of the several indices entering into the equation; to predetermine the relative weights of each such index (in independence of the others); and to evaluate the equation (norms) in terms of the scale of "reformatory capacity," "adaptive ability," "social worth," etc.

4. Any portion of any research, accordingly, can be schematized as an equation, the "result" being at the left of the equality sign and associated or "casual" or "distinguishing" variables at the right, depending on whether correlation or idiosyncrasy be our goal.

5. In all fields of research, it is helpful in thinking to reduce the variables entering into the predictive equations to a minimum. In education and the social science this has often been over-simplified, with the result that thinking has been hindered rather than helped by the attempted simplification.

The variables which we call heredity and environment each consist of varying mixtures of elements which interest one upon another to such an extent that any isolation of one or the other is but an isolation of a group of these, which, in a "well developed" individual studied, are rather highly intercorrelated by reason of the *social organizations* (training, practice, education, experience) which we have effected. It accordingly behooves us not to make too sharp distinctions as to what is and what is not to be included as a legitimate variable for study, or what is or is not a legitimate method of arriving at the hunches, intuitions, and deductions which are essential to research progress. For example, it may be useful to assume that one of the student's traits is the intelligence of his roommate; and the method of its study may be merely personal observation to the effect that the "more intelligent of two roommates is usually the leader." After such an intuition is formed, all that subsequent research can do is to standardize the conditions under which the observations are made, to define the units more precisely and to arrive at the quantitative measures of the traits in question (intelligence and amount of leadership or scholarship) and the functional relationship actually prevailing. The ultimate basis lies in the fact that human beings have the capacity to distinguish (greater intellect—lesser intellect; greater leadership—lesser leadership) and to generalize specific instances into a "rule" or "principle." The "objective" always has its ultimate basis in this "subjective" ability to correctly infer "greater—lesser."

6. Case work, or study of individuals in isolation, presupposes an attempt to pick out the traits which are important, and ascribe to them their relative importance as may be done in the statistical investigation of the problem of uniqueness. The case-worker presupposes an interviewer and an interviewee or an observer and thing observed at first hand. Case work presupposes the necessary training in order to make the discriminations involved in parallel veins; net veins; five sepals, three sepals, etc. No one would think of sending out a case-worker who had not been so trained. The statistical method is scientifically superior in that the probability of duplication is at least roughly known.

It seems to the writer that the case work and descriptive approach is a method which must be used in the initial stages of science when judgment, hunch, and guess work replace actual facts which, in the nature of things, cannot be accumulated hastily. It is axiomatic, however, that anything which can be done by case work method can be done equally as efficiently, and considerably more inexpensively, by giving adequate attention to devising a large scale statistical enterprise, *e.g.*, a questionnaire, rating scale, attitude scale, and test of aptitude or attainment. This statement is true notwithstanding the fact that such development has historically not yet taken place even in some of the most important fields,—important for human welfare—notably medicine.

7. A classification by the fields of research is not a classification of methods of research at all. To admit that one is working on a field of research is an admission of an incomplete research—an investigation of only a few of the possible factors responsible for the behavior of the whole man.

8. From the above considerations, we may say with some propriety that there is only one *method* of research, but many *tools* of research and many *stages of progress in the use of tools* of research. And when it comes to a matter of tools we should remember that the savage, by patient effort, achieves, relative to the times, the same result in making stone axes, which the modern ax maker achieves by use of the most modern pneumatic hammer and steel, only at a much slower rate.

(To be continued in the June number)

SIMPLIFIED METHODS FOR COMPUTING REGRESSION COEFFICIENTS AND PARTIAL AND MULTIPLE CORRELATIONS

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WHILE extensive use is being made of the multiple regression equation in educational research, as well as in certain other fields, its structure and behavior are very mystifying to the lay worker in statistical procedures. He must accept it and its mechanism on the authority of a few experts and operate it, if at all, in a purely rote fashion. Moreover, the methods of working with regression equations that are set forth in sources customarily available to laymen are so involved and difficult as to preclude from their use all but a comparatively few workers. The purpose of this paper is two-fold:

1. To attempt to explain the meaning and the nature of the multiple regression equation, and of multiple and partial correlations, in terms that laymen in statistics can understand.
2. To provide work sheets that will enable anyone who can negotiate relatively simple algebraic manipulations to compute regression coefficients and multiple and partial correlation coefficients.

NATURE AND USE OF THE MULTIPLE REGRESSION EQUATION

We may best approach the problem of the nature and use of the multiple regression equation through some illustrations. An agriculturalist wishes to predict from conditions that obtain up to the end of May what will most likely be the number of bushels of wheat produced per acre in July. This yield will be influenced by several known factors, such as: (1) the aggregate number of inches of rainfall through April and May; (2) the number of days of sunshine through these months; and (3) the average temperature through these months. But these are not of equal importance as factors. In making his estimate he must multiply each by an index number that will most closely accord with its relative degree of importance in affecting the yield of wheat. These several index numbers are the regression coefficients.

Again, we wish to predict a student's grade in school from several factors known in advance. These factors are such as: (1) his intelligence score; (2) time spent in study; (3) health; and (4) the socio-economic status of the home in which he lives. If we wish to predict his scholarship more closely we may not give equal consideration to each

of these factors, but must multiply the scores on each by a coefficient growing out of its relative importance as a factor in producing the result in which we are interested. A critical problem becomes for us, then, the problem of ascertaining what are the relative degrees of importance with which the several components enter in the determination of the criterion, that is, finding the several regression coefficients. Or we may not be interested in the actual prediction; we may merely wish to know the relative weights of the factors as an evidence of their relative importance. Many such problems confront the educational research worker, such as: To what extent do stature, intelligence, quickness of decision, and breadth of scholarship contribute to leadership? In what relative degrees do hours spent in formal drill, in browsing, in listening to lectures, in going to movies contribute to one's knowledge of history? And countless others. These relative weights are found by essentially the same procedure as the coefficients mentioned above. Or, perhaps, we may wish to put the matter in terms of coefficients of correlation because these are more familiar than regression coefficients. We shall then wish to find the extent of correlation between each of our several causative factors and our criterion when the influence of the other factors is ruled out. These correlations which express what may be expected to be the relation between one of a team of factors and a criterion when the influence of the other members of the team is held constant, we call the coefficients of partial correlation. We shall see later that they are very closely akin to the regression coefficients and that they may be derived by essentially the same machinery. Perhaps we may wish to know what is the maximum accuracy with which we could predict a criterion by combining a number of predictive factors each with its "best weight," how high a correlation, that is, we could get in the case of our illustration between scholarship and our four contributing factors listed above taken jointly if we combined these in the best possible proportion. This maximum correlation that may be expected from combining a team of factors is called the coefficient of multiple correlation. It may be found directly from the regression coefficients. When, too, the technique of computing partial correlations can be made sufficiently simple to permit its use by the rank and file of research workers, we shall find it a feasible substitute for parallel-group experimentation where we cannot control certain disturbing variables in our experiment but can rule out their influence upon our findings by the partial correlation technique. It is clear, therefore, that if we can get hold of the secret of finding multiple regression

coefficients we shall have at our command an extremely useful tool in research.

DERIVATION OF THE FUNDAMENTAL "NORMAL EQUATIONS"

Our problem, you remember, is to find multipliers for a team of scores that will give each of the scores best weight in predicting (or producing) a criterion score. Let us put this in the form of an equation. Suppose x_0 is the score of a particular student in scholarship (taken as a deviation from the mean of the scholarship scores rather than as a raw score), and x_1, x_2, x_3, and x_4 are the same student's scores on intelligence, socio-economic status, health, and attendance respectively. Then

$$x_0 = b_1x_1 + b_2x_2 + b_3x_3 + b_4x_4$$

where the b's are the coefficients by which we must multiply the several scores. We do not, of course, know the values of these b's; their values are the very things we are seeking. But it is one of the beauties of algebra that it permits us to play with quantities even if we do not yet know their numerical values; we merely designate them by letters and handle them as such until we can reach the point where we shall have found values for them. We know that there is *some* value by which we must multiply x_1 in order to give it its best weight, and also *some* value for each of the other coefficients, and we merely set b's for these values then proceed to search for the numerical equivalents for these b's as our regression coefficients.

But we have probably measured intelligence, socio-economic status, health, and attendance in terms of different units, so that our x's in the different series are of unlike meaning. To carry them along in this way will cause unnecessary cumbersomeness. Let us, therefore, reduce all of our scores to "standard measures" which have everywhere the same meaning; we can easily return to ordinary scores when we wish. To get "standard measures" we shall divide each deviation score by the standard deviation of the array to which it belongs. We shall let z's stand for the scores in standard measures. Then

$$z_0 = \frac{x_0}{\sigma_0},\ z_1 = \frac{x_1}{\sigma_1},\ z_2 = \frac{x_2}{\sigma_2},\ \text{etc.}$$

We shall also use capital B's for the regression coefficients with standard measures instead of small b's. Our equation then becomes

$$\bar{z}_0 = B_1z_1 + B_2z_2 + B_3z_3 + B_4z_4$$

In order to generalize our equation we merely extend it out toward the right to any number of factors.

$$\bar{z}_0 = B_1z_1 + B_2z_2 + B_3z_3 + \ldots\ldots\ldots\ldots\ldots + B_nz_n$$

Now if only we could apply some algebraic procedure to this equation we might find the values of our several B's. But we are blocked by the fact that we have only one equation and in it a number of unknowns —all of the B's. We are helpless in this sort of situation until we have as many independent equations as there are unknown quantities. Is there any way out?

Yes, there is a way out, a way of getting as many equations as we need, but it involves a little calculus. If the reader is wholly unacquainted with calculus he will find three or four sentences in the development that he will not be able to understand. Inability to follow the development will not, however, interfere at all with a general understanding of the problem nor with the use of the worksheets in calculating regression coefficients. But the reader will need to accept on faith the set of "normal equations" that emerges from the calculus treatment. He may, however, feel assured that "there is a reason" back of them with sufficient defense in exact mathematics.[1]

I have drawn a little horizontal line above the z_0 in the preceding equation. That is to indicate that it would be the value computed (estimated) from the combination on the right. Each score thus estimated from the right side of the equation, when the B's are so determined as to give the best prediction on the average, would miss the correponding student's actual score a little. The error in any one case would be $z_0 - \bar{z}_0$. If we substitute for $\bar{z}_0$ its value from the above equation,

$$z_0 - \bar{z}_0 = [z_0 - (B_1z_1 + B_2z_2 + B_3z_3 + B_4z_4 + \ldots\ldots\ldots + B_nz_n)]$$

Now it is a principle of mathematics that for "best fit" the sum of the squares of the errors should be a minimum. We shall, therefore, square both sides of our equation and indicate by the summation sign that we have passed from considering a single score to the consideration of all the scores, because they all obey the same laws. Indicating the square on the left and squaring out the term on the right, we have

[1] Any reader who has mastered high-school algebra can learn in two or three hours enough calculus to follow this development, and many other fundamental developments in statistics, as well as get very illuminating perspectives on the nature of calculus. We highly recommend this as a worth-while cultural achievement. Obtain Thompson's *Calculus Made Easy*, published by the Macmillan Company.

$$\Sigma(z_0-\bar{z}_0)^2=\Sigma\,(z^2_0+B^2_1z^2_1+B^2_2z^2_2+B^2_3z^2_3+\ldots\ldots\ldots\ldots\ldots+B^2_nz^2_n$$
$$-2z_0z_1B_1-2z_0z_2B_2-2z_0z_3B_3-\ldots\ldots\ldots\ldots\ldots-2z_0z_nB_n$$
$$+2z_1z_2B_1B_2+2z_1z_3B_1B_3+2z_1z_4B_1B_4+\ldots\ldots\ldots+2z_1z_nB_1B_n$$
$$+2z_2z_3B_2B_3+2z_2z_4B_2B_4+2z_2z_5B_2B_5+\ldots+2z_2z_nB_2B_n+\ldots)$$

Now, as was stated above, we want the values of the B's to be such that the right-hand member of our equation will be a minimum. We must, therefore, "differentiate" it and set its "derivative" equal to zero. But, since our equation contains a number of independent variables (the several B's), we must resort to "partial differentiation," that is, we must differentiate separately for each of the variables in turn. Differentiating first with respect to B_1 (and remembering that every term will drop out of our derivative that does not contain a B_1), we have

$$\Sigma(2B_1z_1z_1-2z_0z_1+2B_2z_1z_2+2B_3z_1z_3+2B_4z_1z_4+\ldots\ldots+2B_nz_1z_n)=0$$

We shall now place the summation sign with each of the elements within the parentheses, which is a legitimate way of summating a complex quantity, and also divide through our equation by 2N. Then we have

$$B_1\frac{\Sigma z_1z_1}{N}-\frac{\Sigma z_0z_1}{N}+B_2\frac{\Sigma z_1z_2}{N}+B_3\frac{\Sigma z_1z_3}{N}+B_4\frac{\Sigma z_1z_4}{N}+\ldots+B_n\frac{\Sigma z_1z_n}{N}=0$$

But remember that z_1 equals $\frac{x_1}{\sigma_1}$, z_2 equals $\frac{x_2}{\sigma_2}$, etc. Therefore $\frac{\Sigma z_1z_2}{N}$ equals $\frac{\Sigma x_1x_2}{N\sigma_1\sigma_2}$. But this, it will be observed, is the formula for the Pearson r. For all such quantities in our equation we may, therefore, substitute r's with the proper subscripts. We shall then have (remembering that r_{11} represents perfect self-correlation, which is equal to unity),

$$B_1-r_{01}+B_2r_{12}+B_3r_{13}+B_4r_{14}\ldots\ldots\ldots\ldots\ldots+B_nr_{1n}=0.$$

We must next differentiate in the same way for each of the other B's. The result will be n equations similar in symmetry with the one above. Transposing the terms preceded by the minus sign, we have the following as our set of "normal equations":

$$r_{01}=B_1+B_2r_{12}+B_3r_{13}+B_4r_{14}+B_5r_{15}+B_6r_{16}+\ldots\ldots\ldots\ldots+B_nr_{1n}$$
$$r_{02}=B_1r_{12}+B_2+B_3r_{23}+B_4r_{24}+B_5r_{25}+B_6r_{26}+\ldots\ldots\ldots\ldots+B_nr_{2n}$$
$$r_{03}=B_1r_{13}+B_2r_{23}+B_3+B_4r_{34}+B_5r_{35}+B_6r_{36}+\ldots\ldots\ldots\ldots+B_nr_{3n}$$
$$r_{04}=B_1r_{14}+B_2r_{24}+B_3r_{34}+B_4+B_5r_{45}+B_6r_{46}+\ldots\ldots\ldots\ldots+B_nr_{4n}$$
$$r_{0n}=B_1r_{1n}+B_2r_{2n}+B_3r_{3n}+B_4r_{4n}+B_5r_{5n}+B_6r_{6n}\ldots\ldots\ldots\ldots\ldots+B_n$$

Our concern from the first was to find values for our B's. We have now found our way of doing so. We have as many equations in our set

as we have independent variables. It is therefore, in principle, a very simple matter to solve these equations and find the values of our *B*'s. All that there is to any special method of computing regression coefficients is some method of simplifying the solution of a set of simultaneous equations. Practically every reader has solved such problems in high-school algebra, and you might be interested in trying on this set of equations the methods you learned there, substituting numerical values, of course, for the r's. But you will find the job extremely complex if you use more than two or three variables. The labor mounts rapidly with an increase in the number of equations and becomes enormous after four or five.

THE MOST ECONOMICAL METHODS FOR COMPUTING REGRESSION COEFFICIENTS

The principal trick in working with regression equations is to command some economical method of solving these equations. In the texts on statistics the method customarily explained involves doing in turn a series of partial sigmas and partial r's, each time reducing the partials to a lower order by one. This is the method developed by Yule, which we have called in our tables below the "partial correlations method." But this process gets immensely complicated beyond three or four variables and also involves working with what for the layman are magical procedures the meaning of which he does not grasp. There is needed a simpler and more meaningful method.

Various persons have devised schemes for reducing the labor involved in solving such sets of simultaneous equations. As early as 1855 Gauss developed a method of shortening the process by successive trials and approximations. The determinants treated in texts in college algebra afford a convenient method for solving simultaneous equations for those who are familiar with them. Within the past ten years Truman Kelley developed an indirect method for attacking this particular problem of regression coefficients which he called first "the approximation method" and later, in a further developed form, "the iteration method." But these approximation methods are also difficult to learn and very baffling to laymen. In this and a following article we shall set forth two methods both of which make a direct attack upon the solution of the equations and are therefore more concrete in meaning than the indirect methods. The method to be set forth in our later article is one that merely makes available to laymen the method of determinants but in such form that it makes no demand that he should know the algebra of determinants.

We call this "the Completed Determinants Method." The one to be set forth in this article is the "Doolittle Method."

The Doolittle Method was developed by M. H. Doolittle, of the U. S. Coast and Geodetic Survey, about 1875. For any considerable number of variables it is by far the best method available, yet it has been largely unknown to statistical laymen and nowhere explained in such simplified form that such laymen could readily get hold of it. The Doolittle Method takes advantage of the fact that our set of equations is summetrical to multiply each, as it is used, by such a factor that, when the equations are added, certain terms at the left aggregate zero and are thus eliminated. In this way the number of terms is rapidly reduced to a single unknown which can then be directly calculated. Thereafter the process must be reversed and substitutions progressively made until all of the unknowns have been found. Miss Crossley set up work sheets for this method indicating step by step how the work is to be done. Additional work sheets may be secured from the authors. Our work sheet extends to ten variables but beyond that number the student can make his own formulae by induction from the steps used up to ten variables.

Before presenting our Doolittle work sheet we may say a word as to the economy of the several methods for computing regression coefficients. The accompanying table shows that the Completed-Determinants Method has the smallest number of processes involved in problems of three variables and the Doolittle Method the smallest number from that point on.

ARITHMETICAL PROCESSES INVOLVED IN COMPILATIONS OF REGRESSION COEFFICIENTS BY EACH OF THE SEVERAL METHODS

	Variables	Multiplications	Divisions	Additions	Square Roots	Total Processes
	3	3	4	3	0	10
	4	10	8	8	0	26
Doolittle	5	22	13	15	0	50
Method	6	49	19	24	0	82
(without check)	7	65	26	40	0	131
	3	3	2	3	0	8
Completed	4	17	3	14	0	34
Determinants	5	60	4	51	0	115
Method	6	189	5	151	0	345
	7	641	6	514	0	1161
Approximation	5	130	19	101	9	259
Method	6	192	22	129	10	353
	7	266	46	216	20	548
Iteration	3	28	3	9	0	40
Method	4	69	7	28	0	104
	5	116	10	78	0	204
Partial	3	17	5	12	7	41
Correlations	4	40	12	23	14	89
Method	5	82	26	38	24	170

The Doolittle Method, however, involves relatively more division processes than the Completed-Determinants Method which are slower to handle, and that makes it less economical until past four or five variables. None of the other methods is even a near competitor of these two. In ease of learning the Completed-Determinants Method stands first, as it involves only straight forward substitution. The Partial Correlations Method probably stands next in this respect and the Doolittle Method third. We found that the two Kelley methods are very hard to learn. Besides, they involve the use of judgment, while the other methods are purely mechanical. When we had five subjects experiment with the time required for each of the several methods we found about what the relative number of arithmetical processes would suggest. All of them found the Completed Determinants Method least time-consuming for a three variable problem and four of the five also for a four variable problem, the fifth finding the Doolittle and the Completed-Determinants Methods tied for a four variable problem. Three of the five found the Completed-Determinants Method most economical for a five variable problem while the other two found the Doolittle Method most economical. Beyond five variables the Doolittle Method far exceeded all others in economy. At no level was any of the other methods a near competitor of these two.

CAUTIONS REGARDING REGRESSION COEFFICIENTS

Before closing this introductory statement we must sound some cautions regarding regression equations. In the multiple regression equation the elements are balanced against one another in such delicate ways that their values depend upon very small differentials. If the basic correlations are not valid—correctly calculated and based upon a large number of cases—absurd eccentricities appear in the resulting regression coefficients. In addition to validity of the basic correlations it is essential that the relations be rectilinear. This condition is usually fairly well fulfilled but there are many exceptions. Tests for rectilinearity of regression are given in the textbooks on statistics.[2]

WORK SHEET FOR THE DOOLITTLE METHOD

GENERAL DIRECTIONS

The directions on the accompanying work sheet are so explicit that no difficulty should be encountered in understanding them. It is to be

[2] In our ensuing article we shall, in addition to setting forth our Completed Determinants Method, discuss partial and multiple correlations and show the application of these work sheets to the calculation of them.)

noted that each row (line) has a number and each column a designating letter. These numbers and letters are used in the directions.

The 1 found in the first row and column of each new section is considered in all calculations. It has been placed there permanently because that is always the value of the item in that place.

The work sheet is prepared for calculations up to a ten-variable problem. For any larger number of variables the reader can extend the work sheet by induction from the steps so far presented. For anything less than a ten-variable problem columns not needed should be cut off (marked out) beginning with the J column. Thus, work would be continued only through the H-column for a nine-variable problem, through the G-column for an eight-variable, and so on. (The criterion is always counted as one of the variables.) In all cases, no matter what the number of variables, the I-column is used.

The lower sections also disappear *in toto* with a smaller number of variables than ten. They will disappear below that section where the column with your highest-numbered r-subscript terminates in a 1. But this will not bother you; it will take care of itself.

In the back solution, provided for at the foot of the work sheet, rows and columns also disappear with a smaller number of variables. Beginning at the top of the set of back-solution equations, draw a line through each B on the *left side* of the equations that has a subscript for which you have no corresponding r-subscript. Extend this line all the way across, thus striking out the whole equation constituting that line. Then strike out all columns that have had their respective I's eliminated with the eliminated rows. The remaining elements are all that are needed in the back solution, discussed in our next paragraph.

You need now only find the values of the several B's in these back-solution equations at the foot of the work sheet. They are the regression coefficients you are seeking, each corresponding with a similarly numbered element in your r's. The value of the topmost one is indicated directly in your equation; the others are obtained by successive substitutions in the equations that follow.

But, it must be carefully noted, these B's are not the weights by which you must multiply your *scores* unless these are of a very special type. They are the regression coefficients only for those cases where standard measures have been used or measures in terms of T-scores, P.E.'s, sigmas, or other scores in which all variabilities are equal. They are, how-

Work Sheet for the Doolittle Method

	DIRECTIONS	A	b	C	D	E	F	G	H	J	I	X
1	Insert values for r's	1	r_{12}	r_{13}	r_{14}	r_{15}	r_{16}	r_{17}	r_{18}	r_{19}	$-r_{01}$	ΣA to I
2	Divide Line 1 by −1											
3	Insert values for r's		1	r_{23}	r_{24}	r_{25}	r_{26}	r_{27}	r_{28}	r_{29}	$-r_{02}$	Σb to I
4	Multiply items in Line 1, b to I, by b_2											
5	Add algebraically Lines 3 and 4											
6	Divide Line 5 by negative b_2											
7	Insert values for r's			1	r_{34}	r_{35}	r_{36}	r_{37}	r_{38}	r_{39}	$-r_{03}$	ΣC to I
8	Multiply items in Line 1, C to I, by C_2											
9	Multiply items in Line 5, C to I, by C_4											
10	Add algebraically Lines 7, 8, 9											
11	Divide Line 10 by negative C_{10}											
12	Insert values for r's				1	r_{45}	r_{46}	r_{47}	r_{48}	r_{49}	$-r_{04}$	ΣD to I
13	Multiply items in Line 1, D to I, by D_2											
14	Multiply items in Line 5, D to I, by D_6											
15	Multiply items in Line 10, D to I, by D_{11}											
16	Add algebraically Lines 12, 13, 14, 15											
17	Divide Line 16 by negative D_{16}											
18	Insert values for r's					1	r_{56}	r_{57}	r_{58}	r_{59}	$-r_{05}$	ΣE to I
19	Multiply items in Line 1, E to I, by E_2											
20	Multiply items in Line 5, E to I, by E_6											
21	Multiply items in Line 10, E to I, by E_{11}											
22	Multiply items in Line 16, E to I, by E_{17}											
23	Add algebraically Lines 18, 19, 20, 21, 22											
24	Divide Line 23 by negative E_{23}											
25	Insert values for r's						1	r_{67}	r_{68}	r_{69}	$-r_{06}$	ΣF to I
26	Multiply items in Line 1, F to I, by F_2											
27	Multiply items in Line 5, F to I, by F_6											
28	Multiply items in Line 10, F to I, by F_{11}											
29	Multiply items in Line 16, F to I, by F_{17}											
30	Multiply items in Line 23, F to I, by F_{24}											
31	Add algebraically Lines 25, 26, 27, 28, 29, 30											
32	Divide Line 31 by negative F_{31}											
33	Insert values for r's							1	r_{78}	r_{79}	$-r_{07}$	ΣG to I
34	Multiply items in Line 1, G to I, by G_2											
35	Multiply items in Line 5, G to I, by G_6											
36	Multiply items in Line 10, G to I, by G_{11}											
37	Multiply items in Line 16, G to I, by G_{17}											
38	Multiply items in Line 23, G to I, by G_{24}											
39	Multiply items in Line 31, G to I, by G_{32}											
40	Add algebraically Lines 33, 34, 35, 36, 37, 38, 39											
41	Divide Line 40 by negative G_{40}											
42	Insert values for r's and								1	r_{89}	$-r_{08}$	ΣH to I
43	Multiply items in Line 1, H to I, by H_2											
44	Multiply items in Line 5, H to I, by H_6											
45	Multiply items in Line 10, H to I, by H_{11}											
46	Multiply items in Line 16, H to I, by H_{17}											
47	Multiply items in Line 23, H to I, by H_{24}											
48	Multiply items in Line 31, H to I, by H_{32}											
49	Multiply items in Line 40, H to I, by H_{41}											
50	Add algebraically Lines 42, 43, 44, 45, 46, 47, 48, 49											
51	Divide Line 50 by negative H_{50}											
52	Insert values for r's									1	$-r_{09}$	ΣJ to I
53	Multiply items in Line 1, J to I, by J_2											
54	Multiply items in Line 5, J to I, by J_6											
55	Multiply items in Line 10, J to I, by J_{11}											
56	Multiply items in Line 16, J to I, by J_{17}											
57	Multiply items in Line 23, J to I, by J_{24}											
58	Multiply items in Line 31, J to I, by J_{32}											
59	Multiply items in Line 40, J to I, by J_{41}											
60	Multiply items in Line 50, J to I, by J_{51}											
61	Add algebraically Lines 52, 53, 54, 55, 56, 57, 58, 59, 60											
62	Divide Line 61 by negative J_{61}											

Substitute values from above table for symbols in following equations (B's for each equation found when each variable in turn is solved for) and solve equations for the regression coefficients, B_1, B_2, B_3, — — — — — — B_{10}.

$B_9 = I_{89}$

$B_8 = (B_9)J_{81} + I_{81}$

$B_7 = (B_8)J_{71} + (B_9)H_{81} + I_{71}$

$B_6 = (B_7)J_{62} + (B_8)H_{72} + (B_9)G_{82} + I_{62}$

$B_5 = (B_6)J_{54} + (B_7)H_{64} + (B_8)G_{74} + (B_9)F_{84} + I_{54}$

$B_4 = (B_5)J_{47} + (B_6)H_{57} + (B_7)G_{67} + (B_8)F_{77} + (B_9)E_{87} + I_{47}$

$B_3 = (B_4)J_{33} + (B_5)H_{43} + (B_6)G_{53} + (B_7)F_{63} + (B_8)E_{73} + (B_9)D_{83} + I_{33}$

$B_2 = (B_3)J_{22} + (B_4)H_{32} + (B_5)G_{42} + (B_6)F_{52} + (B_7)E_{62} + (B_8)D_{72} + (B_9)C_{82} + I_{22}$

$B_1 = (B_2)J_{11} + (B_3)H_{21} + (B_4)G_{31} + (B_5)F_{41} + (B_6)E_{51} + (B_7)D_{61} + (B_8)C_{71} + (B_9)b_{91} + I_{11}$

ever, extremely useful as they stand, not only as the regression coefficients of standard measures but also as indexes of the intrinsic importance of the several elements in determining (or at least in predicting) the criterion. Before using them as multipliers of ordinary scores, or before putting them into a regression equation for prediction purposes, each must be multiplied by the ratio of the standard deviation of the criterion to the standard deviation of the distribution of scores with which it corresponds. Our regression equation then becomes:

$$X_0 = B_1\frac{\sigma_0}{\sigma_1}X_1 + B_2\frac{\sigma_0}{\sigma_2}X_2 + B_3\frac{\sigma_0}{\sigma_3}X_3 + \ldots\ldots + B_n\frac{\sigma_0}{\sigma_n}X_n - K.$$

The K that occurs in this "score-form" regression equation is determined as follows:

$$K = B_1\frac{\sigma_0}{\sigma_1}M_1 + B_2\frac{\sigma_0}{\sigma_2}M_2 + B_3\frac{\sigma_0}{\sigma_3}M_3 + \ldots\ldots + B_n\frac{\sigma_0}{\sigma_n}M_n - M_0,$$

where M_0 is the mean of the criterion, X_0; M_1 is the mean of the X_1 factor; M_2, the mean of the X_2 factor; etc.

The X-column in the work sheet is the check for correctness. Its use is optional, but if it is not used the problem should be done simultaneously by two different workers and their results compared from time to time or should be done by the same person twice on different work sheets and perfect consistency required.

The check is to be used as follows: The capital sigma is the summation sign, meaning that you should add together all the items in the line between the limits named, including the limits. The X-column is to be included each time you are told to multiply, add, or divide lines. *But carefully note this exception:* before multiplying any summated item in the X-column by the factor used as a multiplier throughout the line *subtract* from this summation all the items in that line lying to the left of the column with which the multiplications in that line started. For example, in line 14 you are told to "multiply items in line 5, D to I, by D_6." When you extend this multiplication into the X-column you must first subtract from the value standing at X_5 the values at C_5 and b_5 before multiplying the remainder by D_6. A corresponding thing must be done at lines 4, 8, 9, 13, and every other place where such a multiplication is called for.[3]

[3] The spacing in the work sheet on page 392 is too small to permit operations on the page unless with a very sharp pencil. For a work sheet with wider spacing the worker should copy this one on a larger scale or send to the authors for copies.

AN EVALUATION OF GRADUATE TEACHER TRAINING PROGRAMS

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Much emphasis is being placed upon the desirability of longer periods of training for teachers. A considerable number of high-school teachers are enrolling for graduate work in training institutions. Very little is known, however, concerning the types of training that would be most effective for these teachers. At the same time, an analysis of the graduate work pursued by these teachers reveals great variations not only in the courses selected but in other aspects of the training program.

A recent study of the training of 457 high-school teachers of social studies suggested that while their training showed great variations, it was possible to distinguish five types of graduate curricula or training programs.[1] These five types are described below. Without a doubt, other types exist or could be devised. Those included here will serve to indicate the nature of the more common variations. They are not meant to be exhaustive nor are any of them thought of as ideal. It was, of course, impossible to take into account the nature of the course content or the point of view from which the courses might be taught.

CURRICULUM TYPE I

The student chooses history as his major. All of his courses are in advanced history, with no other social science and no education included.

Adviser: A professor who is a specialist in European history.

Thesis problem: "The Influence of Stoicism upon the Thought of Anthony Ashley Cooper, Third Earl of Shaftsbury."

Course work:

European History	9 semester hours
American History	14 semester hours
Bibliography	2 semester hours

Value assigned.....

CURRICULUM TYPE II

The student chooses history as his major. He takes about two-thirds of his work in advanced history courses. The remainder are in other social study fields, with no education courses included.

[1] A more complete discussion is given in Hughes, J. M., and Melby, E. O. *Supervision of Instruction in High School.* Northwestern University Contributions to Education. School of Education Series No. 4. (Bloomington, Illinois: Public School Publishing Company), Chapters 5 and 6.

Adviser: A professor who is a specialist in American History.

Thesis problem: "The Opinions of Missouri Congressmen on Reconstruction."

Course work:		
	European History	6 semester hours
	American History	6 semester hours
	English History	3 semester hours
	Bibliography	2 semester hours
	Political Science	5 semester hours
	Economics	2 semester hours

Value assigned.....

CURRICULUM TYPE III

The student chooses history as his major. He takes about two-thirds of his work in advanced history. The remainder is selected because of the training it affords in the teaching of the subject.

Adviser: A professor who is a specialist in American History.

Thesis problem: "American Property Rights in Mexico under the Constitution of 1917."

Course work:		
	European History	6 semester hours
	American History	6 semester hours
	English History	3 semester hours
	Bibliography	2 semester hours
	Teaching of the Social Sciences	4 semester hours
	High-School Curriculum	2 semester hours

Value assigned.....

CURRICULUM TYPE IV

The student chooses education as his major. The program includes a combination of education and content courses, those in content being chosen to compensate for undergraduate deficiencies in one or more of the social studies, and those in education being chosen because of their relation to the teacher's work.

Adviser: A professor who is a specialist in the field of the teaching of the social studies and in the field of training social study teachers.

Thesis problem: "The Political Science of Everyday Life as Revealed by Analysis of Newspapers and Periodicals."

Course work:		
	Methods of teaching social science	4 semester hours
	High-School Curriculum	2 semester hours
	High-School Administration	3 semester hours
	Guidance in Secondary Schools	2 semester hours
	Methods of Research	2 semester hours

Educational Statistics ..... 2 semester hours
American History ..... 3 semester hours
Sociology ..... 2 semester hours
Political Science ..... 3 semester hours
Value assigned.....

CURRICULUM TYPE V

The student chooses education as his major, selecting all his courses so as to bear either on teaching or on the school as an institution, with no courses in social science.

Adviser: A professor who is a specialist in the field of secondary education.

Thesis problem: "The Cost and Support of Secondary Education in Iowa."

Course work: Methods of Teaching the Social Sciences ..... 4 semester hours
The High-School Curriculum..... 2 semester hours
High-School Administration ..... 3 semester hours
The Measurement of Intelligence..... 3 semester hours
Construction and Use of Tests and Measurements ..... 2 semester hours
Advanced Educational Psychology.... 3 semester hours
Guidance in Secondary Schools..... 2 semester hours
Methods of Research..... 2 semester hours
Educational Statistics ..... 2 semester hours
Value assigned.....

RESUME OF LIKENESSES AND DIFFERENCES OF THE FIVE TYPES

The first three types are alike in that the student majors in history; a history professor is his adviser; and his thesis is a study of some special field in history.

Type II diverges from Type I by permitting some of the courses to be in the other social study fields, such as political science, sociology, or economics. Type III differs from Type I by permitting some of the courses to be in education, courses being selected that bear upon teaching the social studies.

Type IV differs from the others by placing the major emphasis on training the student in the several phases of his work. The courses are selected so that they are distributed over three aspects of the teacher's work—content, teaching, and the school as an institution.

Type V differs from IV by omitting all social science content and having the student spend all of his time upon the teaching and the school as an institution. In this curriculum the courses in educational psychology replace the content courses.

EVALUATION OF THE CURRICULUM TYPES

It would seem obvious that not all of these programs are equally well designed to meet the needs of high-school social science teachers. Probably the question cannot be settled by appeal to authority. Yet it was believed that it would be helpful to training institutions and to teachers in training to know the judgments of employing officers and specialists in education concerning the effectiveness of the several types of curricula. The five types of programs were, therefore, submitted to six groups of educators, replies being received from 71 superintendents of schools, 141 high-school principals, 67 high-school teachers of social science, 24 heads of social science departments, 26 university professors of history, and 48 educational specialists. These groups were asked to rate the programs in accordance with the following instructions:

EXPLANATIONS AND DIRECTIONS

Five different types of training programs for prospective teachers of social studies have been enumerated. In judging these programs, assume that the undergraduate training of all those pursuing them was similar. Each student has an A. B. degree from an Arts College, with a major in history and a minor in other social sciences. Assume that all had from 15 to 19 hours in undergraduate courses in education.

Consider the five programs and decide upon the one you think is best as graduate training for a high-school teacher of social studies. Assign this a value of 100. Next, select the program you think is the poorest, or least effective. Assign this a value of 0. Then assign to each of the other three a value between 0 and 100 as your judgment may dictate.

THE RESULTS OF THE EVALUATIONS

The percentages of the six groups of educators who assigned first rank to each of the five types of programs are given in Table I. In a general way one might say that all groups disapprove of Types I and V. Over the remaining three types there is a pronounced difference of opinion.

TABLE I

THE PERCENTAGES OF SIX GROUPS OF EDUCATORS WHO ASSIGNED FIRST RANK TO FIVE TYPES OF CURRICULA FOR TRAINING OF SOCIAL SCIENCE TEACHERS

	Percentages					
Type of Curriculum	Superintendents	Principals	Department Heads	History Professors	Teachers of Social Studies	Specialists in Education
I	0.0	0.0	4.1	4	1.5	0
II	7.0	4.2	37.5	36	13.4	2
III	35.2	36.2	25.0	48	52.7	25
IV	53.5	56.7	33.3	12	35.8	73
V	4.2	2.8	.0	0	0	0

It is to be noted that there is fairly close agreement between the judgments of educational specialists, superintendents, and principals—all of the three groups favoring Type IV, with Type III as second choice. The specialists are particularly pronounced in their support of Type IV.

AVERAGE VALUES ASSIGNED

It was believed that a summary of the average values assigned to the types would give some measure of the relative effectiveness of the five types of programs as viewed by the judges. The average values assigned by administrators and specialists to the five types of programs correspond closely. Likewise, the values assigned by social studies teachers, heads of departments, and history professors are similar. It should be noted that the three last-named groups give much higher values to Types I and II than do administrators. More than half of the specialists assigned a value of zero to Type I, while the average of the values they assign is only about 7. Their ratings of Type II are only slightly higher. History professors and department heads rate Type II almost as high as Type III. The highest value for Type I is given by history professors, while the highest value for Type V comes from administrators.

TABLE II

THE AVERAGE PERCENTAGE VALUES ASSIGNED TO FIVE TYPES OF CURRICULUMS BY SIX GROUPS OF EDUCATORS

Type of Curriculum	Percentage Values					
	Superintendents	Principals	Department Heads	History Professors	Teachers of Social Studies	Specialists in Education
I	15.7	15.0	34.0	51.4	32.0	7.1
II	49.3	52.9	76.9	80.83	67.6	8.8
III	78.2	79.1	80.6	85.4	87.7	74.1
IV	78.5	84.1	67.3	50.0	68.8	88.9
V	44.4	40.4	15.8	4.0	29.0	36.9

If the judges favoring Types III and IV as shown by rank order are combined, the majority of all groups will be included. This may be interpreted to mean that the majority of all groups believe that the graduate curriculum for the training of social studies teachers, regardless of what department the teacher is enrolled in, should be made up of properly selected courses from both the professional and content fields. The question is thus reduced to one of emphasis, history professors holding that the emphasis should be placed on the content side, while specialists in education and administrators would emphasize professional training.

COMMENTS OF JUDGES

The back of the form used was reserved for comments, a large number of persons in all groups making such comments. A great many of

them are interesting, but only a few representative statements can be given here. From one point of view there were three groups which participated in the investigation. First, there were superintendents and principals who are employers and supervisors of teachers; secondly, there were teachers and department heads; and finally, history professors and specialists may be said to represent those who train teachers. It has been thought best to review the comments under three main heads; namely, teachers, administrators, and training specialists.

COMMENTS OF TEACHERS AND DEPARTMENT HEADS

The comments made by teachers are very conflicting in character. Opinion ranges all the way from those who believe that the entire graduate year should be devoted to methods of teaching, to those who believe that graduate training should be spent entirely on content. There are also occasional expressions of dissatisfaction with the training work now provided. Education courses are said to be barren, and content courses are judged to be remote from the teacher's work in high school. Others find fault with the thesis subjects or with the thesis requirement.

"Teaching methods are secondary. The first consideration is subject matter and the teacher who is full of his subject has the foundation upon which to become an inspiring teacher."

"The important thing is to know one's subject and to have as large a cultural background as possible. The teacher interested in his work will be able to keep in touch with the best teaching through reading."

"Teaching to-day has become a highly technical business and a year devoted almost exclusively to mastering its theory and technique is not too much to ask. If the work of the undergraduate has been of the right sort the student will have gained the historical attitude and interest together with some positive knowledge."

STATEMENTS OF ADMINISTRATORS

The statements made by superintendents of schools and principals of high schools are, in a general way, quite similar. As employers and supervisors of teachers the administrative officers emphasize the importance of good training in methods of teaching. They recall their experiences with teachers who possessed knowledge of subject matter with little knowledge of children. As has already been shown, more than half of the administrators prefer Curriculum Type IV, and this attitude is also reflected in the comments they make. There are a few notable exceptions where administrators emphasize the importance of content in the training of the teacher of social studies, but they are relatively few in number. Again, there are those who call attention to the importance of both

content and method, suggesting that an equal amount of emphasis be given to the two aspects of the teacher's training.

STATEMENTS OF SUPERINTENDENTS OF SCHOOLS

"We feel that for high-school teachers the best combination is for them to use their undergraduate program for content courses and their graduate work in the study of the technique of presenting the subject."

"Too many of our graduate students come into the high school with the attitude of the worker in the field of 'pure research.' There is a science and a technique in modern education. This is most highly developed in the elementary school and for this reason the lack of its development in the secondary school is a handicap to pupils trained in a modern progressive elementary school."

"The teacher of social studies must know his field but must have in addition a *knowledge of modern instructional technique*. The lack of supervision in secondary education makes this knowledge more important."

"I believe the social science teacher should be a developer of individuals, not a teacher of subjects. This requires a background of information in the major field with special attention to methods adapted to the teaching of the study and training which enables the teacher to develop the counselor attitude."

"Most of our social science teachers are very weak in methods. They know the subjects but not the methods. They know how to teach knowledge content but they do not know how to develop human motives."

STATEMENTS OF HIGH-SCHOOL PRINCIPALS

"We all know by bitter experience the futility of expecting just any A. B. recipient to teach successfully. Knowledge of a subject *per se* has little to do with successful teaching. On the other hand, we cannot expect a well-trained teacher to teach history without a mastery of the content in that field. Type V is marked down, therefore, but still fairly high since the content knowledge can and will be acquired by the intelligent teacher who finds himself under contract to teach."

"Without previous training in education the young teacher acquires his skill at the expense of the pupils who come under him. I should welcome the requirement of a Master of Education degree for all Class A public secondary schools."

"I would favor as near an approach to *half* education and *half* social science program as major and minor requirements permit."

"Fifteen years as a high-school principal has convinced me that there is a big supply of social science teachers who know the field and that a teacher with a good scholastic record and an A.B. degree has *knowledge* enough. The shortage is in teachers who have, besides, knowledge of the field, a concept of modern secondary education. This sometimes comes as a result of an M.A. in Education. It never comes as a result of an M.A. in the special field."

COMMENTS OF SPECIALISTS IN EDUCATION AND HISTORY

While there are differences of opinion within the two groups, one may say that history professors stress the importance of content, and specialists in education emphasize method. It is to be observed, however that educators do not wish to exclude content from the training program, while history specialists in some cases would exclude education courses from graduate training. One might describe the attitude of the groups somewhat as follows: Education specialists advocate thorough training in content and method. They also want the teacher to have a thorough understanding of the school as an institution. They demand a type of content which will function in teaching high-school students. History professors believe that if the teacher knows history he will be in possession of the most important requisite for effective teaching. They admit the need for knowledge of teaching methods, but they believe such knowledge can be secured in undergraduate work or through experience.

COMMENTS OF EDUCATION SPECIALISTS

"My conviction is that teachers should have at least three well-developed elements in preparation; something to teach, to know how best to teach, and a sense of values in respect to what is to be taught and how to teach it. Too large an emphasis on mechanics of teaching leads to an oversight of the learner as an individual; too large an emphasis on the materials leads to a distortion of values."

"All the programs lack the greatest essential factor needed—supervised student teaching on the graduate level. All are overbalanced one way or another—either too much omission of study of subject matter, or too much omission of subject matter.

"In general I am convinced that the emphasis upon research ability and advanced work in subject matter disqualifies one for teaching high-school pupils or for preparing teachers for high-school pupils. The point of view to be cultivated is 'What can this social science course do for this high-school boy?' The point of view commonly taken by those who have been trained to worship 'a great subject,' is 'What a mess these kids make of this course!'"

COMMENTS OF HISTORY PROFESSORS

"Between Types I and II there is little to choose. Type III is passable, Type V as 'graduate training for a teacher of social studies' is ridiculous, and Type IV is not much better."

"My rating strongly emphasizes the value of content courses as preparation for high-school teachers of the social studies. My experience with freshman and sophomore students in history has convinced me of the futility of high-school teaching of history by teachers who are well up

on methods but have not had rigorous training in advanced courses in the subjects taught."

"Type IV could be improved by substituting a few history courses instead of the education courses."

"I think those who teach content courses should be mindful of the fact that the student is to become a teacher."

"My feeling is that too much stress is placed on the theory of education in presenting education courses. There is too much duplication of content in the various courses."

"I am quite opposed to the view held and expounded by some educators that if a teacher knows how to teach and has the theory of teaching well in hand, that he is prepared to teach any subject. Certainly a prospective teacher should have spent more time getting control of the content of the subject to be taught than he should spend on the theory of teaching."

IMPLICATIONS

If the foregoing data lead to any definite conclusion, it is that the problem of the most desirable training for high-school teachers is in a very unsettled condition. Wide differences of opinion exist between various groups of educators. Differences exist likewise within groups. Both educational specialists and subject matter specialists would insist that they have the right to pass judgment upon the type of training to be established for teachers. We thus have two groups of experts in the field of teacher training, neither one of which is willing to concede to the other the prerogative of determining the programs of training for teachers. That education is on the way to becoming a science is not fully recognized by the subject-matter specialist.

In the last analysis, however, the judgments of employing officers are of importance. Training institutions must meet the demands of these officers. According to the judgments of principals and superintendents as brought out in this study, the graduate training of the teacher must give definite recognition to both content and method.

A number of questions are raised by the comments made by members of the several groups. Some of the questions relate to elements in the programs rather than to the types of curricula. For example, it is evident that there is not complete satisfaction with the training provided either in content or professional courses. It is said that content courses are not taught from the point of view of teachers in training, while education courses are said to be theoretical and "dry."

There is also criticism of the content itself. We are told that teachers do not understand modern society; that their content training is too

narrow; that better preparation should be given in social problems, economics, and government. If all these demands are to be met adequately, the one year of graduate training will, no doubt, be insufficient. There are those who believe that one year could well be devoted to professional courses alone. If a wide variety of social science courses are also to be provided, an additional year would be necessary. In fact, there would seem to be no difficulty in utilizing the three years commonly required for the Ph. D. degree which is already possessed by some high-school teachers.

As the training period is lengthened, the nature of the training continues to be a serious problem. Will training programs modeled after those now pursued by college and university instructors in training meet the needs of teachers in the secondary schools? Certainly in the judgments of superintendents, principals, and educational specialists they will not. The evidence favors content and professional courses in both undergraduate and graduate training as well as in all levels of graduate preparation.

ECONOMY OF TIME IN COLLEGE INSTRUCTION

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THE PROBLEM STATED

THIS paper aims to deal with the problem: What is the effect of differences in teaching time upon student ability in an academic subject? If classes A and B, taught by the same instructor and equated for initial ability, are so administered that A meets three hours weekly and B only two hours, what differences in accomplishment are measurable at the end of the course? Will the extra hour of contact with the instructor render A superior, equal, or inferior in achievement to B?

EXPERIMENTAL PROCEDURE

During the fall semester of 1929, the writer was fortunate in having two sections each of elementary and educational psychology which could readily be adapted to the purposes of this investigation. In the discussion which follows, Group A in both courses refers to the sections which met relatively more often each week, and Group B to those sections which met less often. A, then, is the control, and B the experimental group. It should be noted that no attempt to segregate students on any basis whatsoever was made.

It will be convenient to consider each course separately. The two divisions of elementary psychology used the same pair of standard textbooks, met in the same room, performed the same experiments, and witnessed the same demonstrations. A mimeographed syllabus outlining the topics of the course was distributed to both groups with the admonition that they would be held responsible for some acquaintance with all the items in the outline, even though they might not be covered in detail during the semester. This was designed to facilitate individual library work. A selected reference shelf of twelve "classics" dealing with various branches of psychology was reserved for the members of the class, and familiarity with some portions of each demanded. The sole difference between the two sections was that Group B had only two lecture-recitation periods weekly while Group A had three. Group B was encouraged to use the free hour for wider reading but similar recommendations were made to Group A. The instructor obviously had to compress the substance of his lectures more with Group B, eliminating minor points, reducing the variety of illustration, and abbreviating stu-

dent inquiries; in Group A, on the other hand, the extra hour was used for stressing technical distinctions, presenting illustrative material, such as slides, charts, etc., and informal discussion. A student in Group B normally attended class only 67 percent as often as one enrolled in Group A.

For purposes of comparison, a pre-test of two hundred true-false items comprising elements drawn from earlier "tested" tests of all the departmental members was administered during the first week of the term. The reliability of the test as determined by the odd-even technique was .86 ± .02. This same test was later given as part of the final examination.

For the course in educational psychology (to which elementary psychology is a prerequisite) the following arrangement was devised: Group A met twice weekly for lectures; the third hour allotted to the course in the catalogue was set free as a reading period. Group B met once weekly for a lecture and also had one period free for "outside" reading; in addition, Group B was divided into squads of four students, each squad meeting in conference at the instructor's office. At this conference, individual reading assignments based on the expressed interests of the student were made. The length of the semester permitted meeting each squad twice, once for outlining a program of reading and again for a report thereon. Thus, as a group the average weekly class attendance per student for Groups A and B stood in the ratio roughly of 100 to 62.

An achievement test of 175 true-false items and 30 multiple-choice elements was taken by both sections at the beginning and end of the term. This test has a reliability of .81 ± .03. Making allowance for the difference in subject-matter in the two courses, the remaining instructional procedure followed the same pattern described above for the classes in elementary psychology. The objective in this case was to determine at what stage in the curve of reduction for student or teacher class-hours the law of diminishing returns began to operate; i.e., if two hours of instruction weekly yielded just as good results as three, would one hour also produce results normally obtained with two?

RESULTS

Table I shows the initial and final average scores based on unregulated class enrollment without any endeavor to match individuals.

It will be observed that the amount of progress during the course as measured by gain in test units is about the same for both groups. The averages, to be sure, are not alike, but then they were not identical originally. The final difference is hardly larger than the original differ-

TABLE I

COMPARATIVE SCORES OF TWO SECTIONS IN ELEMENTARY PSYCHOLOGY

Group	N	Average Intelligence	S.D.	Initial Average	S.D.	Final Average	S.D.	Gain
A	25	94.6	24.7	112.0	9.75	130.02	11.53	18.02
B	46	95.95	24.06	114.25	12.45	132.91	15.95	18.66
				D=2.25		D=2.89		
				SD_{diff}=2.68		SD_{diff}=3.29		
				D/SD_{diff}= .84		D/SD_{diff}= .88		

ence, and both differences are in themselves unreliable. The chances of a true difference between the two initial and the two final averages remain at almost the same ratio—80 in 100 as compared with 81 in 100.

Table II presents similar data for the course in educational psychology.

TABLE II

COMPARATIVE SCORES OF TWO SECTIONS IN EDUCATIONAL PSYCHOLOGY

Group	N	Average Intelligence	S.D.	Initial Average	S.D.	Final Average	S.D.	Gain
A	59	109.41	23.78	45.08	16.01	64.55	18.49	19.47
B	30	107.73	22.53	38.9	14.68	60.93	17.12	22.03
				D=6.18		D=3.62		
				SD_{diff}=3.40		SD_{diff}=3.94		
				D/SD_{diff}=1.82		D/SD_{diff}= .92		

As in the case of Table I, the amount of improvement as measured by the increase in the number of correct test items is practically alike for both groups; if anything, the section with the least "benefit of teaching" as such made the better showing. It is also interesting to note that this equivalence of effect remains unaltered regardless of whether a large or small class is selected for the time reduction. The chances of a true difference between the averages of the two classes has been diminished rather than enhanced by the situation to which the students were exposed (as represented by the lowering of the chances of a true difference from 97 in 100 to 82 in 100.)

THE MATCHING CHECK

The inevitable conclusion to which the foregoing discussion would seem to lead is that within the temporal limits here considered (one to three hours weekly) achievement in course work varies independently of the time spent in formal contact of student with instructor. Experience has long since taught that this holds for the superior pupil, but that it is also valid for the general run of the student-body appears a bit startling. To see whether the preliminary indications of Tables I and II would be confirmed by the more orthodox matching technique, the following procedure was adopted:

In the elementary class, each of the 25 individuals in Group A was paired for native ability with a corresponding member of Group B. Scores on the DeCamp Intelligence Test (taken by all students admitted to Pennsylvania State College) were used for this purpose. No difficulty was encountered in assigning mates, as only 3 differences out of 25 were greater than 2, the largest discrepancy being 9 points in intelligence. (The $P.E._M$ of a single Decamp score = 5.65.) Table III gives the final averages for these groups of approximately equal capacity.

TABLE III

COMPARATIVE SCORES IN ELEMENTARY PSYCHOLOGY WHEN INTELLIGENCE IS A CONSTANT

Group	N	Average Intelligence	S.D.	Final Average	S.D.
A	25	94.6	24.7	130.02	11.53
B	25	93.75	24.3	128.9	13.7
				D = 1.12	
				SD_{diff} = 3.57	
				D/SD_{diff} = .31	

It is obvious that where there are only 62 chances in 100 of a real difference being present, the variation between the two averages is quite insignificant.

In addition, it was thought desirable to match the groups separately for specific psychological knowledge. It is conceivable that of two persons with the same intellectual endowment, one may begin the course with a greater acquaintance with particular facts of human nature. Consequently, the subjects in both groups were equated on the basis of their pre-test scores. Only 4 differences out of 25 were greater than 2, the largest divergence being 14 points; this was balanced, however, by a zero difference in fully half the cases. Table IV gives the final averages when the initial test scores are equalized; the pairs in this Table are all distinct from those in Table III.

TABLE IV

COMPARATIVE SCORES IN ELEMENTARY PSYCHOLOGY WHEN INITIAL KNOWLEDGE IS HELD CONSTANT

Group	N	Pre-Test Average	S.D.	Final Average	S.D.
A	25	112.0	9.73	130.02	11.53
B	25	112.9	10.5	134.16	10.8
				D = 4.14	
				SD_{diff} = 3.16	
				D/SD_{diff} = 1.31	

The obtained difference between the averages is 1.31 times its sigma, giving 90 chances in 100 of a true difference. These figures should be contrasted with those for Table III. Whereas in Table III the chances mildly favored the group meeting more often, in Table IV the situation is reversed more positively in favor of the class meeting less often.

Similar methods of verification were followed with the educational psychology groups. Matching for intelligence was easily accomplished, only 3 pairs in 30 having differences greater than 3. Table V shows the results obtained by this method.

TABLE V

COMPARATIVE SCORES IN EDUCATIONAL PSYCHOLOGY WHEN INTELLIGENCE IS A CONSTANT

Group	N	Average Intelligence	S.D.	Final Average	S.D.
A	30	108.65	23.4	62.86	20.5
B	30	107.73	22.53	60.93	17.12
				D = 1.93	
				SD_{diff} = 4.87	
				D/SD_{diff} = .39	

Since the difference again is but .39 times its standard deviation, there are only 65 chances in 100 that one group is genuinely superior to the other.

In an advanced course in any subject, however, it is generally agreed that previous achievement in similar work constitutes a better prophecy of the probable level of attainment than any mental test. For this reason, matching on the basis of pre-test scores was resorted to. Two-thirds of the pairs had identical scores and in no instance was a difference greater than 3 present. Our final comparison appears in Table VI.

TABLE VI

COMPARATIVE SCORES IN EDUCATIONAL PSYCHOLOGY WHEN INITIAL KNOWLEDGE IS HELD CONSTANT

Group	N	Pre-Test Average	S.D.	Final Average	S.D.
A	30	39.03	14.2	61.9	20.5
B	30	38.9	14.68	60.93	17.12
				D = 1.03	
				SD_{diff} = 4.87	
				D/SD_{diff} = .21	

An index of .21 gives just 58 chances in 100 that a significant difference is present.

SUMMARY

This study deals with the question: Is it possible for students of equal ability and preparation to learn as much of a given subject-matter in less than the standard number of class-hours as those who are held to the full schedule requirements?

The pre-test and post-test averages on achievement tests in elementary and educational psychology were compared for sections matched and equated in various ways. No statistically significant differences were detectable.

CONCLUSION

As all the tables indicate, a uniform and consistent outcome is manifested regardless of the device employed in comparing the different groups. It is difficult to find a plausible explanation of these results. The limitations of this investigation, however, should be emphasized. It may be that the facts here reported are valid only for two courses, one instructor, and one method; and it is open to question whether larger or smaller classes would have yielded the same returns. Furthermore, the sections which attended class more frequently may have derived intangible benefits over and above the gains measurable by the testing instrument. However, the suspicion is not altogether unwarranted that the normal college class may be meeting oftener than is necessary for maximum learning efficieney. Self-education under ordinary conditions appears to yield results just as satisfactory as those obtained by added classroom instruction.

SHORTER ARTICLES

ESTIMATES IN STATISTICAL WORK

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IN combining the test scores of candidates in the Indiana Edison contest last summer the committee was forced by the shortness of time to make extensive use of estimates. A subsequent check-up showed that the results of these estimates were almost identical with what longer calculations would have yielded. It is believed that approximations may legitimately find a wider use in applied statistics, and the methods used in this case are here described in support of this position.

The candidates were tested in five subjects, and the following weights had been arbitrarily set for these tests by the committee: general science, intelligence, and mathematics, one each; general information, one-half; physics (or chemistry), two. Under the conditions of administration it was necessary to approximate these weights as nearly as possible by inspectional methods. The steps in this rough work follow.

The distribution of scores for each test was examined. They were roughly of the same shape so that, with slight modifications, their ranges could be used as an index of their relative variability. The first three series, to be weighted equally, had ranges of 44, 54, and 64, and these were considered satisfactory under the circumstances. The fourth series had a range of 90; but 30 points of this range were due to two scores, so that the series was divided by only two to give it, roughly, half the weight of the first three series. The physics scores showed a range of 120, twenty points of which were due to two scores. This series was to be weighted twice as much as the first three series, and it was regarded satisfactory in its natural state.

Twenty-two of the 80 candidates had been allowed to take two short chemistry tests in lieu of the physics test. In order to make these scores statistically equivalent to the physics scores, it was necessary to equate them on the basis of average and of variability. Some difficulty arose because the scores on the two chemistry tests were tabulated separately, so that it was necessary to estimate the average and the variability of the series that would result from adding together the two chemistry

scores of each student. The mean of a series of combined scores is equal to the sum of the means of the separate series, and it was assumed that this would be sufficiently true of the medians. The sum of the medians of the two chemistry series was 47 points higher than the median of the physics scores, so that this amount was subtracted from the combined chemistry scores.

Equating the chemistry and physics scores for variability involved other assumptions. The variability of a series composed of two other series is equal to the sum of the variabilities of these two series if they are perfectly correlated, and it is reduced somewhat as the correlation between the two series decreases.[1] The sum of the ranges of the two chemistry series was 113. It was assumed that a sufficient correlation would exist between the two series of chemistry scores so that the 113 would not be reduced much below the range of the physics scores—100 with the two extreme cases removed. The chemistry scores could therefore be used in place of physics scores merely by combining them and subtracting 47.

On the basis of these estimates, total scores for the candidates were obtained by adding the raw scores on the five tests, taking only half of the score in general information, and subtracting 47 from the totals of those who took chemistry instead of physics. These results correlated to the extent of $\rho = .9998$, $r = .989$ ($N = 80$) with total scores obtained by using the arbitrary weights and employing means and standard deviations, with no estimating.

It is not to be inferred that such procedures will always prove this satisfactory. In the present case the tests had a sufficiently high correlation among themselves so that the various approximations resulted in a negligible error. Each situation should be studied to see whether the conditions are such as to mitigate errors in estimates, and whether the errors will probably lie within the required limits of accuracy. The tendency, however, is undoubtedly to refine computations beyond what is necessary.

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[1] The standard deviation of a series formed by adding paired values of two series is: $\sigma_{(x+y)} = \sqrt{\sigma^2_x + \sigma^2_y + 2r\sigma_x \sigma_y}$. If $r = 1$, this becomes $\sqrt{\sigma^2_x + \sigma^2_y + 2\sigma_x \sigma_y} = \sigma_x + \sigma_y$. The value of the radical is much more stable than the value of r. For example, if $\sigma_x = 5$, and $\sigma_y = 5$, and $r = 1$, then $\sigma_{(x+y)} = 10$; if r is reduced to .5, $\sigma_{(x+y)} = 8.7$; and if r is reduced to 0, $\sigma_{(x+y)} = 7.1$. Hence the assumption following in the text is not unreasonable.

SEX DIFFERENCES IN HIGH-SCHOOL CHEMISTRY

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NATURE AND SCOPE OF WORK

THE purpose of this investigation is to study the relative performance of boys and girls in high-school chemistry. It was conducted in a large city high school having an enrollment of approximately two thousand pupils. Ten forty-minute periods per week were devoted to chemistry, the time being apportioned among recitation work, supervised study, or laboratory and demonstration work. The course in general harmonized with such courses as have been recommended by national education committees, and *A First Book in Chemistry* by Bradbury was used as a text. Three experienced teachers taught the classes according to a definitely outlined program and a time-schedule to assure an equivalence of teaching conditions.

INTELLIGENCE OF PUPILS

The Terman Group Test of Mental Ability was administered to 230 pupils, comprising 125 boys and 105 girls enrolled in the first semester and second semester classes. A comparison of test norms appears to indicate that the general intelligence levels of the two groups are not much higher than we should ordinarily expect to find in groups of

TABLE I

COMPARISON OF TEST NORMS[1] WITH TERMAN NORMS

	Terman Norms		Norms of this study	
	11th yr.	12th yr.	Boys (125)	Girls (105)
U. Q. Score	163	169	170	161
Median Score	138	147	141	141
I Q Score	112	122	116	123

[1] Approximately three-fourths of the pupils involved were classified as 11th year pupils.

unselected pupils. While the variability of the boys proved to be somewhat greater than that of the girls, the median scores for the two groups are the same. The results of the test are given in Table I.

AGES OF PUPILS

An average acceleration of five months for the girls is to be noted when their ages are compared with those of the boys in Table II.

As no information is available relative to the earlier records of these pupils or to other factors (e.g. health, interests, habits, etc.), which

TABLE II

AGES OF PUPILS[2]

	Average		Oldest		Youngest		Range	
	yrs.	mo.	yrs.	mo.	yrs.	mo.	yrs.	mo.
Boys (125)	16	8	23	1	14	1	9	0
Girls (105)	16	3	18	9	14	8	4	1
Difference	0	5						

[2] All ages given represent ages at the time pupils enrolled in Chemistry. The oldest pupil (23-1) re-entered after an absence of nearly five years. IQ's obtained for oldest and youngest pupils were as follows: *107* (23-1), *95* (18-9), *123* (14-1), and *124* (14-8).

doubtlessly influenced earlier grade-placements or promotions, it is not possible to account for this difference. Certainly the factor of intelligence alone does not account for it. Boys again exhibit a somewhat greater variability.

PREVIOUS SCIENCE PREPARATION

Slightly more than one-half the number of pupils had received training in sciences other than chemistry as the data in Tables III and IV indicate.

TABLE III

PREVIOUS SCIENCE PREPARATION

	N	Number taking one or more sciences	Percent
Boys	125	84	67.2
Girls	105	35	33.3
Total	230	119	51.73

Approximately two-thirds of the boys had been enrolled in other sciences while one-third of the girls had taken other work. The original data further show that eight boys and one girl had studied three sciences other than chemistry; two sciences other than chemistry had been taken by twenty-seven boys and five girls, while forty-nine boys and twenty-nine girls had been enrolled in one science other than chemistry. Not only has the preparation of the boys been more wide-spread, but it has been more intensive as well.

TABLE IV

DISTRIBUTION OF BOYS AND GIRLS IN VARIOUS SCIENCE COURSES

	Boys (125)		Girls (105)		Difference
Subject	No.	%	No.	%	%
General Science	22	17.6	3	2.9	14.7
Biology	48	38.4	32	30.5	7.9
Physiography	10	8.0	0	0.0	8.0
Physiology	4	3.2	1	.95	2.25
Physics	43	34.4	6	5.7	28.7

THE TESTING PROGRAM

A series of twenty improvised tests were used in testing achievement upon the completion of the various units of work covered. Individual test items were based upon the subject-matter covered by the textbook in use and upon material incorporated in the course of study. Most of the items had received preliminary try-outs previously, and many objectionable ones had already been eliminated. Rich Chemistry Tests, Gamma and Epsilon, were given upon the completion of the half-year's work, and again at the end of the year; an improvised Inventory Test was given at the beginning, after one semester of instruction, and again at the close of the term. Altogether there were 905 items making up these twenty-five tests, ranging from ten items per test for those concerned with gas problems and chemical arithmetic, to one hundred items for the Inventory Tests. Fourteen of these tests were administered to pupils in chemistry I, or the first-semester group (7 sections), and eleven to those in chemistry II or the second-semester group (5 sections). The exact numbers of pupils taking the various tests are given in Table V.

THE RELIABILITY OF THE TESTS

Coefficients of reliability for the various tests were determined by breaking the tests up into 'chance-halves', correlating the two sets of scores, and applying the Spearman-Brown prophecy formula. Reliability coefficients obtained for seven of the tests (280 items) including the

TABLE V

SUBJECT-MATERIAL OF TESTS, NUMBERS OF BOYS AND GIRLS TAKING THE TESTS, STANDARD DEVIATIONS AND RELIABILITY COEFFICIENTS OF TESTS

No. of Test	Nature of Test	BOYS N.	BOYS S.D.	GIRLS N.	GIRLS S.D.	Reliability
1.	Inventory Test	71	13.37	57	8.24	.78
2.	Oxygen	71	16.09	55	16.00	.769
3.	Gas Laws; problems	71	31.80	55	30.51	.829
4.	Water and Solution	66	15.42	55	15.71	.738
5.	Chemical Arithmetic	72	26.43	51	21.84	.809
6.	Acids, etc., Valence, Nomenclature	68	14.35	56	16.97	.89
7.	Chemical Terms and Formulas	65	10.30	55	10.86	.656
8.	Formulas and Common Names	63	21.10	56	23.39	.83
9.	Chemical Terms and Common Names	65	18.89	56	20.70	.91
10.	Equation balancing	67	24.86	49	25.96	.87
11.	Inventory Test (one semester)	88	19.08	77	16.25	.69
12.	Rich Tests, Gamma and Epsilon	86	8.77	75	7.87	.70[1]
13.	Baking Powders	44	19.69	43	17.34	.782
14.	Soaps	46	18.27	44	14.38	.714
15.	Calcium Compounds	45	13.67	43	12.49	.687
16.	Nitric Acid; Explosives, etc.	46	16.40	41	18.02	.89
17.	Periodic Law; Electromotive Series	47	12.53	41	11.40	.95
18.	Rich Tests (two semesters)	44	11.66	40	8.94	.70[1]

[1] Author's reliability coefficients for the Rich Tests.

final Inventory Test, and tests concerning subject-matter suggested by the headings (1) Elements; Mixtures, etc., (2) Hydrogen, (3) Normal Solutions; Titration, (4) Air, Atmosphere, (5) Sodium; Solvay Process, and (6) Ammonia proved to be too low to warrant considering them sufficiently accurate for group measurement. These tests, therefore, have not been considered in subsequent analyses. Reliability coefficients for the eighteen tests remaining are given in Table V. The average marks of boys and girls for these eighteen tests are given in Table VI.

TABLE VI

AVERAGE MARKS OF BOYS AND GIRLS; DIFFERENCES BETWEEN AVERAGES INTERPRETED IN TERMS OF THE PROBABLE ERROR OF THE DIFFERENCE AND THE "CRITICAL RATIO"

No. of Test	Average and PE (av.) Boys	Girls	Diff (Obt.)	PE (diff)	$\frac{D}{PE\ (diff)}$ (Critical Ratio)
1.	15.1 ± 1.06	6.1 ± .73	9.0	1.29	6.7
2.	75.6 ± 1.28	70.1 ± 1.44	5.5	2.0	2.75
3.	52.6 ± 2.53	43.7 ± 2.75	8.9	3.74	2.4
4.	73.0 ± 1.27	69.6 ± 1.42	3.4	1.9	1.8
5.	63.0 ± 2.08	57.8 ± 2.04	5.2	2.91	1.78
6.	65.8 ± 1.18	60.2 ± 1.52	5.6	1.92	2.92
7.	87.6 ± .855	85.7 ± .98	1.9	1.3	1.46
8.	79.2 ± 1.78	73.8 ± 2.08	5.4	2.74	1.97
9.	84.4 ± 1.54	78.5 ± 1.85	5.9	2.43	2.43
10.	41.6 ± 2.04	35.1 ± 2.48	6.5	3.2	2.03
11.	39.1 ± 1.36	30.2 ± 1.24	8.9	1.84	4.83
12.	41.6 ± .63	39.7 ± .609	1.9	.88	2.15
13.	73.9 ± 1.98	74.8 ± 1.77	.9	2.64	.34
14.	80.4 ± 1.8	78.3 ± 1.45	2.1	2.3	.9
15.	77.9 ± 1.36	78.4 ± 1.27	.5	1.86	.26
16.	70.0 ± 1.62	67.8 ± 1.88	2.2	2.48	.887
17.	80.0 ± 1.17	81.5 ± 1.19	1.5	1.67	.898
18.	50.5 ± 1.18	47.7 ± .95	2.8	1.51	1.85

Average scores of the boys range from 1.9 points to 9.0 points higher than those of the girls on 15 of the 18 tests, or on about 83 percent of the work covered; averages of the girls on three of the tests, namely 13, 15, and 17, are respectively .9, .5 and 1.5 points higher than those of the boys. Such unanalyzed evidence, taken at its face value, would indicate a marked superiority of performance in favor of the boys. Since a critical ratio of 3 or 4 indicates that an obtained difference between averages is reliable, only two of the ratios (tests 1 and 11) are found to be large enough to be considered indicative of differences that are statistically reliable. The critical ratios for tests 2, 3, 6, 9, 10, and 12 indicate a further tendency in favor of the boys as is true with tests 4, 5, 7, 8, and 18 with critical ratios that are slightly smaller. For tests 13, 15, and 17, on which the girls averaged slightly higher than the boys, the differences are not statistically significant.

SUMMARY AND CONCLUSIONS

There is apparently no great difference to be noted in the general intelligence levels of boys and girls involved; median intelligence scores for the two groups are identical. Boys, however, are five months older than girls and have had the advantage of a more general as well as more extensive training in the sciences. Boys exhibit greater variability with respect to intelligence and maturity. In 15 of the 18 tests the boys were found to be superior to the girls. In two tests, and possibly in six others, the differences were found to be statistically significant.

Since the performance of boys has been superior on the work given during the first term and on the tests concerned with subject-matter of a general nature, it appears quite likely that the more extensive science preparation of the boys has been a factor in their favor.

EDITORIALS

EDUCATIONAL TERMINOLOGY

In another portion of this journal is published a "Symposium on the Classification of Educational Research." For various reasons, the classifications submitted by the contributors to this Symposium are not in complete agreement. One of the causes of the lack of agreement among these contributors, that is of particular interest to the writer, is the tendency to run into the same classification categories chosen from different points of view. This reminds one of a point frequently emphasized in description which is to the effect that the point of view should not be shifted without warning.

The writer's primary interest here is not in the Symposium on the Classification of Educational Research, but in the fact that there are probably many classifications in the literature of education that are more or less indefensible. One learns, for example, that there are four ways (more or less) of getting experience: (1) by participation (or doing); (2) by observation; (3) by reading and conversing with others (the verbal mode); and (4) by reflective thinking. One naturally wonders whether there really are four modes of acquiring experience or whether there are just three modes (that is, from this point of view), and whether the fourth (critical thinking) is not merely a condition necessary for effective operation. The writer may be in error in this particular illustration, but it appears, nevertheless, that there is a considerable amount of false classifying in the subject of education, due, not merely to the improper subordination of ideas, but to the shifting of the points of view in classification.

Closely related to this matter of educational classification is the matter of educational terminology. Assuming that it is the ultimate purpose of educational writing to instruct, the writer finds it difficult to understand many of those who write upon educational subjects, not merely because of poorly constructed sentences, poorly organized paragraphs, and errors of grammar, but because of the many meanings attributable to the symbols that writers use. It has been frequently observed that the meanings of words seem never to be fixed; they vary from time to time, from place to place, and from individual to individual.

There is to-day, for example, a lot of discussion in this country, and, for that matter, in the world at large, of the *activities* curriculum, *experience*, and learning by *doing*. However enthusiastic one may be about these matters, one finds it exceedingly difficult to understand what is meant, and, consequently, one is in no position to evaluate fairly the contribution of these terms to educational thought. One naturally wonders what the users of these words mean; what is *experience?* What is an *activity?* What is *doing?* Do all activities produce *experience?* Are *activities* and *experience* synonymous? The psychologists frequently use the expression, *reaction*. Does learning by experience mean learning by *reacting?* etc. One really wonders whether the individuals interested in this type of education have an idea or whether it is merely a layman's way of expressing a psychological fact. In a similar manner one wonders what is meant by the *integration of personality, creative education, functionally taught subject matter,* and a number of like expressions in current use.

Now the purpose of this illustration is not to tread on the toes of the so-called progressive educator with whom the writer finds much in common, but to point again, as many others have done, to the problem of educational terminology. It appears to the writer that more attention needs to be given in educational writing to the careful definition and differentiation of terms, both those in current use and those of earlier and of different historical periods. There are many people who speak glibly about educational matters without fully realizing that they may not know what they are talking about, and that, even when they do, others may not understand them. It seems to the writer that a fuller appreciation of this fact should lead to a better understanding among both the producers and consumers of educational literature.

A. S. Barr

REVIEWS

Address all communications relative to book reviews to Editor E. J. Ashbaugh, Miami University, Oxford, Ohio.

HURD, ARCHER WILLIS. *Problems of Science Teaching.* Minneapolis: University of Minnesota Press, 1929. xi + 195 pp.

The investigation reported is important for two reasons: It seems to be an acknowledgment that college level teaching needs investigation; it represents a worthy attempt to measure college level teaching objectively. These points may be put in a slightly different way by saying that some college teachers are now recognizing the truth that all teaching involves two things: knowledge of the content to be taught and *the ability to put the content across.* There is no attempt to separate these two points; they are inseparable. But now a few college teachers do separate them in that they recognize no problem of teaching other than knowledge of content.

The program of investigation described in the volume fell into five divisions: (1) studies of prerequisite courses and the relations to sequent courses, (2) the aims and objectives of science courses as related to social and industrial life, (3) problems of instruction in science, (4) measurements of achievement in science, and (5) costs of instruction.

The work very properly advocates a need for experimentation in these fields as the best basis for satisfactory answers to each problem. A digest of the experimental work thus far done in these fields is given. Approximately twenty-five investigations are cited and tentative conclusions of each investigation are noted.

The specific experimental work done by the various science departments of Minnesota University are given in detail in the remaining chapters of the book.

The first experiment dealt with the problem of the results of laboratory work in physiology as compared with combined laboratory and library work. The set-up is as follows: Section A was assigned seven and a half hours work in the laboratory; Section B was given five hours for its laboratory work and two and a half hours of assigned library work. Other controllable factors were kept constant. The results were measured by ratings in each for the following: Mid-Quarter; Final written; Total objective score; Final Oral; 5-minute Quiz; Term Laboratory and Final Laboratory. The total of the ratings for Section A is 607.8 while that for Section B is 557.7. Section A was superior to B in all ratings except that in the Final Oral examination. Treated from the angle of reliability of differences, Section A reveals significant *advantages* in the Mid-Quarter, the 5-minute Quiz and the Term Laboratory ratings. Section B on the same basis reveals no significant *advantages.*

A second experiment involved experimentation on the numbers of students who worked coöperatively on a cadaver. Two students were chosen according to one type of grouping and four students,

according to the other type. A series of objective tests, which were given to both groups failed to distinctly reveal conclusive evidence for either type of treatment. The students themselves did express a decided preference for the two-student grouping. Should one expect very marked differences in such an experiment? Probably not. The amount of laboratory practice given the larger group is sufficient to develop technical skill in this field. The differences in the set-up were possibly not large enough in the beginning.

The results of the various experiments give rise to nineteen conclusions. Among those cited the following deal with interesting problems: (4) There is additional evidence that class size is not a significant factor in achievement in elementary physics under present instructional conditions. (6) Abilities presumably gained in the laboratory have not been measured objectively as yet. (19) Achievement in mechanics is significantly higher on the average for those who have had high-school physics.

Allow a repetition of the comment that the projection of so large a problem into the field of experimentation and the subjection of the data thus gained to statistical treatment are in themselves outstanding contributions. There are two matters that one does think of in connection with such a treatment, however. (1) Do these methods measure the best results of training? (2) Is it possible to determine in a relatively short span of a student's life the ultimate significances of the training offered him? There still is ample justification for the type of experimentation described in this work, even if both of the above questions are answered in the negative. The effects of this experiment must be studied over longer periods of time in order to discover their total significances. Certainly no long-time study could be thought complete without the results that are recorded here.

The techniques employed seem to be entirely satisfactory. The work utilizes the better of the modern methods of statistical treatment and results are clearly put.

E. E. RAMSEY
Indiana State Teachers College

KING, WILLIAM A. *The Elementary School Library.* New York: Charles Scribner's Sons, 1929. xiii + 224 pp.

It is of more than passing interest that this, the first book devoted exclusively to the consideration of the library in the elementary school, should have been written by an administrator rather than by a school librarian. It would seem to indicate that there is a growing appreciation of the importance of the library in the attainment of modern education objectives by those whose support is vital.

The book treats of such topics as the major objectives of the elementary-school library, pupil activities in the library, the housing of the library, its furniture and equipment, its organization and administration, the qualifications of the teacher-librarian, coöperation with the public library, training in the intelligent use of the library and reading guidance. More practical treatments could well have been provided for the important subjects of finance and the securing of librarians.

The author's very special interest in reading pervades the entire book. This interest perhaps accounts for his recommendation in platoon schools of "reading-library departments" and "reading-library teachers" who shall not only interrelate and coördinate the materials of the various subjects of the curriculum but also teach the mechanics of reading, the

reading skills. The administrator may consider such a procedure an economy, but school librarians will doubtless contend that their duties are already sufficiently onerous and to require more of them will lessen their efficiency as librarians.

Of considerable help and value are the specimens of platoon-school time schedules, lists of pupils' library activities, graded courses of study in library training for elementary-school pupils, varied lists of children's books and magazines and a scale for measuring the efficiency of an elementary-school library. The illustrations—a list of these does not appear after the Table of Contents—do not seem to have been selected with the best judgment. How much more effective and suggestive would pictures of groups of pupils using the various resources of the library be than the full-page reproductions of a dictionary stand, a catalog cabinet, a bulletin board! Again, some will wish that the "Selected References" consisted of more than a few oft-repeated titles and that the two-page index were more extensive.

The book will be most useful to those who administer platoon schools or who cannot employ full-time school librarians. Others will find suggestions worthy of adaptation to or trial in their libraries. To secure the librarian's point of view Lucile F. Fargo's recently published *The Program for Elementary School Service* should also be read.

L. Belle Voegelein
Library of Congress

McGowan, Ellen B. *A Comparative Study of Detergents.* New York: Columbia University, 1930, vi + 126 pp.

The author has covered a very large number of subjects in this short study. The purpose of the book is to give the grade and high-school instructor useable data appropriate for the grade in which the subject is presented. To that end there has been assembled not only a review of current literature on the subject but also a fair amount of factual data accumulated through personal research in the laboratories of the School of Practical Arts, Teachers College, Columbia University.

In eleven divisions the subject of dirt, textile fibers, water, soap and its action as a detergent and as a bactericide is discussed. A very brief summary of the various types and tests for cleaners and detergents is given, at times very simply and at other times with all the technical terminology of the physical chemist. The average reader, unless he has studied physical chemistry and knows colloidal states, hydrogen ion concentrations and the laws of measuring surface tensions, will feel very much at a loss to secure practical applications in solving the problems in the household use of detergents. A glossary and an index would seem essential if the book is to have general use, since the older dictionaries may not aid the reader who is not familiar with the technical terms. Even a sophomore student in college would find much of the material too briefly explained; yet part of it is simple enough for the child in the sixth grade to comprehend.

Under the subject of water, it is to be regretted that the zeolite process for household use, and the possibility of household utilization of calcium-aluminum precipitation method available for softening water for country houses is not more definitely emphasized. The chemical reactions for softening water are not sufficiently detailed to be of value to the person who is not a chemist and are unnecessary for the person who is.

The colloidal purposes of soap are mentioned on page 33, and again on page 44, but are not in any way explained until page 52. Cross page references or an index would have been of value to the intelligent but non-technical reader. There is much value in the factual material presented, facts that are extremely difficult to get from articles in technical journals, that it is too bad to conceal the data through the use of little understood terms.

Chapter 11, *Educational Aspects*, is unusually well presented and every teacher who has taken the time to read the book will find suggestions not only good educationally but extremely practical and easy to follow. The first two chapters and the last chapter are treated simply. The intervening chapters could very well be written with the same simplicity improving and extending the value of the book materially. As it is there is no book at this moderate cost that can be substituted for this study.

There is an excellent bibliography.

A. L. MARLATT.

University of Wisconsin

LEONARD, EUGENIE A. *Concerning Our Girls and What They Tell Us.* New York: Columbia University, 1930. vi + 192 pp.

Woman, uncertain, coy, and hard to please; woman, the riddle of the ages, may yet yield her mystery to the cold dissection of the scientist. Little by little the dark unfathomed caves of human personality give up their hidden secrets to the psychologist; and the hieroglyphics of character are being translated by painstaking interpreters.

Dr. Leonard has found a way to plumb these hidden depths. The mother-child relationship has possibilities of the greatest importance for character. Dr. Leonard has chosen the mother-daughter relationship, and in her questionnaires limits questions to what she calls the religious aspect. But her meaning of religious aspect is extremely broad.

One hundred life situations were selected, and several types of responses were elicited about these situations. The responses revealed the attitude or experience of the daughter in relation to her mother. Here is an example:

"When you and some friends do something you know your mother doesn't approve, but which you think is all right:

A. Do you tell your mother all about it?.....Yes.....No

B. Do you just mention it in conversation?.....Yes.....No

C. Do you say nothing about it to her?.....Yes.....No

D. Why?

Supplementary Question: Do you and your friends sometimes do things you are a little ashamed of afterward? .....Yes .....No."

Here are some of the returns to this question:

"Negative Responses:

'I'm afraid of what she will say or do.' 'She would yell.' 'She would scold.' 'She is always angry.' 'It would only worry her.'

Positive Responses:

'I might get her to see my point of view.'

'I want to know what she thinks, and find out if I'm wrong.'

'We should both express our viewpoints.'"

In addition to the statistical compilations from the 303 questionnaire sets, forty cases were selected for intensive study. Final summaries of results are most illuminating and suggestive to all who are working with girls or with par-

ents. Only selections from these "Implications of the study" can be given.

What interferes with confidences between mother and daughter? (1) Any display of emotionality by the mother, such as scolding, yelling, fussing, weeping. (2) Mother too busy. (3) Lack of interest on mother's part. (4) Some form of ridicule by mother. (5) Mother's lack of ability to help.

Maternal attitudes which foster confidences include unending patience, wholehearted interest in the girl herself, seeing the problem from the girl's standpoint, and knowledge or wisdom to help the girl.

Perhaps in this whole study this statement gives most food for thought: "It is of more than passing interest in relation to our problem that nearly every girl studied was impressed with how busy her mother was. It seems strange that with all our devices for saving labor, with all our education for life, so many mothers have so little time to live with their daughters." JESSIE A. CHARTERS

Ohio State University

PYLE, WILLIAM HENRY. *The Psychology of the Common Branches.* Baltimore: Warwick and York, 1930. vii + 381 pp.

Dr. Pyle has produced a very useful, teachable, and productive contribution to the psychology of teaching. In this book the principles essential to the effective teaching of reading, spelling, handwriting, and arithmetic are set forth. There are four main divisions in the treatment of each subject: (1) the text proper in which are stated the main facts with such discussion as seems necessary, (2) exercises and problems for the student, (3) concise numbered statements of all the essential principles, and (4) brief abstracts of the articles and books in the field. There is a very complete bibliography with the best and latest material on the subject.

The book is not only one that can be used as a textbook but it is an exceptionally good reference book. Most of the books of the past ten years on this subject are out of date. Here is one that has brought all of the fundamental subjects up to date.

The book should be a great aid to the normal school teachers and should be a ready reference for critic teachers in the training schools. On the whole it is one of the valuable contributions of the past year. C. E. BENSON

New York University

HILDRETH, GERTRUDE H. *Psychological Service for School Problems.* Yonkers-on-Hudson: World Book Company, 1930. xiii + 317 pp.

The book attempts to give a description of those services which psychology has brought into the field of education over and above the service that was considered standard for schools during the generation preceding the present. The author asserts that education to-day implies more than supervision of instruction and teaching. It implies modifications to be made in child behavior. Dr. Terman in the editor's introduction writes as follows: "No educational program may safely ignore the facts of child development or fail to take full cognizance of individual differences in pupils. Psychological methods occupy an important place in determining curricula, remedial teaching, guidance and counseling, the adjustment of problem children, and parent education."

Throughout the book the author lays stress on the fact that the causal factors in the case of problem children who are

capable of normal adjustment lie primarily in neglect or superficial education. The massing of tests and placing of children into ability groups have their values but they do not go deep enough. There must be expert skill to determine the causes of maladjustment and the remedies that are best. The study of abnormal adults and of difficult cases in the upper grades shows that behavior problems have their inception in childhood.

The first portion of the book deals with the applications of psychology to educational problems and service, and to the principles of measurement and testing. Then follows suggested treatment of the individual pupil, the exceptional child, and pupil classification and guidance. One chapter develops remedial work in the various subjects of the elementary grades. Finally, a general treatment is given of records, report cards, research problems, and administrative detail.

Much of the discussion is very common and represents a repetition for most students in this field, yet it is well organized and the book makes a rather complete unit for the student who is not familiar with previous writings relating to psychological and research service in education.

The treatment of the exceptional child is well developed. Wholesome emphasis is likewise well placed on the study of the "whole child." He must not be treated as though he were three separate entities, a "mental child," an "emotional child," and a "social child."

The appendix contains an excellent bibliography of three hundred ninety-one selected references. It also contains a helpful bibliography of mental tests, subject tests, and personality tests and scales for elementary and junior high-school grades.

The author is to be commended for the presentation in simple, non-technical language which any student may read and understand.

The book should be helpful to students who wish to know more about the general service of psychology as shown by clinics and research bureaus. In addition it gives to the worker who wishes to delve deeper into any of the topics treated a wealth of reference materials.

VIRGIL E. DICKSON
Assistant Superintendent of Schools, Berkeley, California

SNEDDEN, DAVID. *School Educations: Sociological Sources of Values.* New York: Columbia University, 1930. v + 187 pp.

Everyone who knows Dr. Snedden recognizes his tremendous physical vitality. Most of his lectures and writings show an equal intellectual vitality. This is particularly true of this his latest volume. It indicates a thorough acquaintance with American life in all its varied manifestations and a keen analytical and critical understanding of our educational problems.

It nevertheless reveals serious weaknesses as a text. To many students it will appear to be a conglomeration of somewhat obscure outlines, analyses, hypothetical propositions and talk. The abler and more experienced students, however, will find it a mine of stimulating discussions, mainly critical, but not devoid of constructive suggestions. Were it more carefully organized, separating the outlines from the analyses and tying the questions and problems into manageable units, it would be a valuable guide in many advanced courses in Educational Sociology.

While in general sound, some of the foundational principles of the book are open to question. To the reviewer the division of teachers into policy makers and ordinary classroom instructors, and the attempt to educate them as such, is essentially vicious. It would preclude any possibility of professionalizing teaching. As well might we try to educate some physicians as policy makers and others as practitioners. Only in its last stages is it safe to differentiate in the curricular training of any profession. Sound policy making must emerge from the minute accretions of thinkers and any assumption that the administrative type of mind is more capable of clear thinking than other types is without psychological or sociological warrant. Likewise, it seems to the reviewer both impossible and undesirable, as Dr. Snedden seems to advocate, to divorce vocational and cultural, or producer and consumer, education. Such a separation would reduce vocational education to a routine training in detailed skills and appreciational education to platitudinous generalizations and insipid pedagogy.

In spite of its shortcomings as a text, the book should prove a useful reference in many classes and is so stimulating and vital that the reviewer hopes it will have many readers.

WALTER R. SMITH
University of Kansas

RESEARCH ABSTRACTS and BIBLIOGRAPHIES

Address all communications relative to research abstracts and bibliographies to Editor A. S. Barr, University of Wisconsin, Madison, Wisconsin.

BULLETINS

BOYER, CARL WRIGHT. *The Psychology of the College Student Who is Scholastically Deficient.* Doctor's Dissertation, School of Education, New York University, 1931.

A study of the causes of scholastic deficiencies of college students: (a) quality of work done in subjects passed; (b) the factor of intelligence; (c) grades received according to class year; etc.

CHEYNEY, W. WALKER. *Rate of Progress and the IQ.* Doctor's Thesis in Education. Philadelphia: University of Pennsylvania, 1930. 98 pp.

The author presents a study of the factors conditioning the progress of pupils in elementary schools. After studying the relation of a number of factors to school progress, he concludes that intelligence is the most important factor, with poor health contributing somewhat; and other factors, such as reading ability, number of children in the family, occupation of father, home conditions, and physical conditions, contributing not at all.

DEBUSK, BURCHARD WOODSON, AND LEIGHTON, RALPH WALDO. "A Study of Pupil Achievement and Attendant Problems," *University of Oregon Publication,* II (February, 1931), 163-200.

An illustrative study of pupil achievement relating to mental age, ability, and classification of pupils. The authors show that the system of grading and classifying pupils in the school systems studied resulted in extreme spread of mental ability, extreme differences in achievement standards in different schools, extreme differences in achievement in each class and in each grade, and a number of related topics.

HUFFAKER, C. L. "Teacher Supply and Demand in Oregon," *University of Oregon Publication,* II (January, 1931), 97-156.

Discusses the number of new teachers required in the state of Oregon, the supply, the preparation of new teachers, teaching experience of new teachers, teachers in new locations, salaries of new teachers, married women as teachers, etc.

"Record of Current Educational Publications," *Bulletin of the Office of Education,* United States Department of the Interior, 1931. 118 pp.

Contains a record of current educational publications in the following fields: nursery-kindergarten-primary education, elementary education, secondary education, exceptional children, junior colleges, teacher training, colleges, universities, and graduate schools, public-school administration, adult education, vocational education and guidance, negro education, and foreign education.

ROBERTS, MARY E. *Elimination from the Public High Schools of New Jersey*

(*1925-1929*). Doctor's Thesis in Education. Philadelphia: University of Pennsylvania, 1930. 251 pp.

A study of the extent and probable causes of elimination from the public high schools of New Jersey, in which such factors as sex, color, chronological age, grade classification, curriculum, health, etc., were studied. The author concludes that about 15 percent of the student body will probably be eliminated during the course of any given school year; that there is a slightly greater elimination among boys than among girls; that the mortality of the colored students is approximately 7 percent greater than that of the white; that an underaged pupil has approximately twice the chance of remaining in school that a normal aged pupil has, and three times the chance of an overaged pupil; that pupils of foreign born parentage are more likely to be eliminated than those of American parentage; and that repeated absence from school is likely to be a forerunner of elimination.

San Antonio Junior Schools Mathematics Experiment in Comparative Courses of Study. San Antonio, Texas: San Antonio Junior Schools, 1931.

A preliminary report of a comparative study of three mathematics courses of study in the San Antonio Junior High Schools, San Antonio, Texas.

"The Principal at Work on His Problems," *Research Bulletin of the National Education Association*, IX (March, 1931), 94-158.

Contains material on the principal as a person; the principal as head of the single school unit: administration, supervision, etc.; the principal as a worker in the school system: relations with the superintendent, coöperation with supervisors, etc.; and the principal as an active participant in a professional group: educational associations, principals' organizations, research groups, etc.

"The Report of the Committee on Collegiate Educational Research, University of Minnesota, for the Biennium 1928-1930," *Bulletin of the University of Minnesota*, XXXIV (February 2, 1931), 148 pp.

Contains reports from the various committees, with a bibliography of publications.

WILLIAMS, L. A. "The Person-Consciousness of a Selected Group of High-School Pupils," *University of California Publications in Education*, VI (March 26, 1931), 85-138.

A study of the extent to which schools are successful in making the lives of great persons real forces in the formulation of ideals and attitudes in boys and girls.

EDUCATIONAL ADMINISTRATION AND SUPERVISION

ASELTINE, JOHN. "The Duties of a Department Head in a Large City High School," *School Review*, XXXIX (April, 1931), 272-279.

An analysis of the duties performed by heads of departments in the San Diego Senior High School, San Diego, California.

CHAPIN, F. STUART. "Research Studies of Extracurricular Activities and Their Significance in Reflecting Social Changes," *Journal of Educational Sociology*, IV (April, 1931), 491-498.

A summary of a number of research studies relating to extracurricular activi-

ties from which the author concludes that the field of social interaction and leadership shows that the masses of students exhibit diminishing participation as the number of groups increases; and that leaders show increasing participation as the number of groups increases. The author thinks that this tendency is general in application.

"Ethics of the Teaching Profession," *Kansas City School Service Bulletin*, III (March, 1931), 13 pp.

This bulletin reprints the code of ethics of the National Education Association, the Des Moines teacher's creed, the ten commandments for the American teacher, with bibliography.

GILBERT, LUTHER C. "Activities of Junior College Transfers," *Junior College Journal*, I (April, 1931), 418-426.

An analysis of the records of junior college transfers at Stanford University to discover the number and kinds of activities engaged in by junior college students. The findings indicate that the junior college offers wide opportunities for student activities and that junior college students outrank state university students in membership in these activities. Junior college transfers to Stanford University are distinctly superior, both in academic ability and achievement, to students who have entered directly from the high school.

HOLY, T. C., AND SUTTON, D. H. "Determining Essential Apparatus," *Educational Research Bulletin*, Ohio State University, X (April 1, 1931), 171-177, 196.

A study of laboratory equipment for high-school science courses.

JACOBSEN, JOHN M. "Athletics and Scholarship in the High School," *School Review*, XXXIX (April, 1931), 280-287.

A summary of 17 investigations relating to the relations between athletics and scholarship in the high school.

KLEIN, ARTHUR J. "Survey of Land-Grant Colleges," *Journal of Higher Education*, II (April, 1931), 169-176.

The first of a series of articles on land-grant colleges.

WHITE, CLYDE W. "The Effects of Exemptions from Semester Examinations on the Distribution of School Marks," *School Review*, XXXIX (April, 1931), 293-299.

A statistical investigation from which the author concludes that the general distribution of marks are changed very little under the exemption system.

EXPERIMENTAL STUDIES OF LEARNING

FLEMING, ELIZABETH A. "A Comparative Study of the Whole and the Part Method of Teaching the Typewriting Keyboard," *Pittsburgh Schools*, V (January, February, 1931), 91-95.

An experimental study from which it appears that the part method of teaching the keyboard of the typewriter has an advantage over the whole method.

GECK, L. H. AD. "German Publications in 1929 and 1930 on Problems of Social Education," *Journal of Educational Sociology*, IV (April, 1931), 499-507.

A review with critical comments of a number of German publications on the subject of social education.

HOLTORF, HERBERT. "*Das Problem der Ueber bürdung in jugend psychol-*

ogischer Beleuchtung (The Problem of Overburdening in the Light of Youth-psychological Research), *Zeitschrift für Angewandte Psychologie*, XXXVIII (February, 1931), 1-119.

A questionnaire investigation conducted among students of four German universities and other secondary schools. The problem of the investigation is "Did you feel overburdened in school?" A total of 730 replies were carefully analyzed by case method technique. Through various refinements of the data, the following maximal percentages of overburdened students are found: *gymnasium* 15.5 percent, *realgymnasium* 16.4 percent, *oberrealschule* 23.3 percent, *oberlyzeum* 23.8 percent, *reformrealgymnasium* 24.8 percent, *deutsche oberschule* of the type of the *Aufban schule* 36.1 percent; all secondary schools of the nine year type 19.4 percent, and all secondary schools including the *Aufbanschule* 20.1 percent. Overburdening is found to a greater degree among the good students than among the poor students. From 30.4 percent of the replying students living in large cities, 35.3 percent reported to be overburdened; from 35.6 percent living in medium sized cities, 35.3 percent, reported to be overburdened; and from 33.2 percent living in small cities, 29.2 percent reported to be overburdened. The socio-economic conditions seem to have only a very minor influence on the fact of overburdening in school work.

MILLER, ARTHUR L. "A Project in Art Appreciation," *School Review*, XXXIX (April, 1931), 300-306.

A statistical study of a special project in art history in the Foch Intermediate School, Detroit, Michigan.

OSBURN, W. J., AND DRENNAN, L. J. "Problem Solving in Arithmetic," *Educational Research Bulletin*, Ohio State University, X (March 4, 1931), 123-128.

An experimental study of transfer from arithmetic problems which are specifically taught to those which are not given particular mention in instruction, made in the Madison Elementary School, Wheeling, West Virginia. The authors conclude that there is a marked amount of transfer.

SAND, GEORG. "*Ueber die Erziehbarkeit von Intelligenzleistung bei Schwach begabten kindern*, (About the educability of dull children in intelligent performances)," *Archiv für die gesamte Psychologie*, LXXVI (¾ 1930), 387-464.

Synthetical experiments with number-series tests in thirty-five fourth and fifth grades. By class and individual coaching the author finds that intelligent performances are not only caused by intelligence but that they are also caused by training. The superior intelligence indicates itself, not only by the degree to which an individual can solve new problems, but also to the extent that he can be taught.

TOUTON, FRANK C., AND BERRY, BETTY T. "Reading Comprehension at the Junior College Level," *California Quarterly of Secondary Education*, VI (April, 1931), 245-251.

An analysis of 20,003 errors of reading comprehension of 738 entrants at the University of Southern California.

PUPIL ADJUSTMENT, GUIDANCE, AND WELFARE

EELLS, WALTER CROSBY, AND JONES, HALLY F. "Higher Educational Aspirations of California Junior College

Students," *California Quarterly of Secondary Education*, VI (April, 1931), 239-244.

A preliminary report of the higher educational aspirations of junior college students based upon returns from 11,000 students in 47 coöperating junior colleges, from which it seems that many students of average ability plan to attend institutions of learning.

CURRICULUM RESEARCH

DALE, EDGAR. "Difficulties in Vocabulary Research," *Educational Research Bulletin*, Ohio State University, X (March 4, 1931), 119-122.

A brief critical statement of some of the difficulties involved in vocabulary research.

GUILER, WALTER S. "Analysis of Punctuation Errors," *Educational Method*, X (April, 1931), 425-429.

An analysis of punctuation errors based upon tests in English given to the entering freshmen in the School of Education of Miami University.

PARKER, EDITH PUTNAM. "Making a Curriculum in Geography." DOUGLASS, CARLETON, E., "Progress in Curriculum Construction in the Intermediate Grades." ADAMS, MARY A., "City-Wide Experimentation in the Intermediate Curriculum Program in Geography and History." TYSON, MILDRED E., "Laying the Foundation for History-Geography." WELLS, LAURA M., "The Effect of the Course of Study Program Upon the Teaching of Geography." BRAUN, MARY S., "History as an Integrating Agent." GAREIS, MARGARET S., "Supervisory Field Activities in Connection with the New Course of Study in Geography." BROWN, MARY E., "A Reading Lesson Based on a History Unit." *Baltimore Bulletin of Education*, IX (April, 1931), 191 pp.

This issue contains a series of articles on the new courses of history and geography for the intermediate grades in the Baltimore Public Schools.

WORCESTER, D. A. "Purpose and College Attendance," *Journal of Higher Education*, II (April, 1931), 190-194.

The author finds the high-school Latin group did slightly better college work than non-Latin students, but he also finds many other environmental factors favorable to the Latin group, such that it is difficult to ascertain the true explanation of the differences noted.

MEASUREMENTS, STATISTICS, AND METHODS OF EDUCATIONAL RESEARCH

FERGER, WIRTH F. "The Nature and Use of the Harmonic Mean," *Journal of the American Statistical Association*, XXVI (March, 1931), 36-40.

The author points out that there are many errors in the use of the harmonic mean, and suggests ways of determining when the arithmetic and the harmonic means should be used.

MANWILLER, CHARLES E. "Diagnostic Analysis of Test Results," *Pittsburgh Schools*, V (January-February, 1931), 81-90.

A discussion of how classroom teachers may make diagnostic use of standardized tests.

RICHARDS, HENRY I. "Analysis of the Spurious Effect of High Inter-Correlation of Independent Variables on Regression and Correlation Coefficients," *Journal of the American Statistical*

Association, XXVI (March, 1931), 21-29.

It is sometimes assumed that spurious results are obtained when the intercorrelation of two or more independent factors is perfect due to some cause that does not affect the results obtained when the intercorrelation is less than one. The author presents data indicating the conditions under which this statement holds true.

RORTY, MALCOLM C. "Statistics and the Scientific Method," *Journal of the American Statistical Association*, XXVI (March, 1931), 1-10.

The author points out that the statistician must be instinctively and primarily a logician and a scientist in the broadest sense. He also stresses the importance of setting up, as far as possible, not only one but several independent proofs of his conclusions.

SKEELES, ARTHUR G. "Research and Thinking," *Educational Administration and Supervision*, XVII (April, 1931), 294-305.

The author emphasizes the importance of good thinking as a part of the research procedure.

TYLER, RALPH W. "What is Statistical Significance?" *Educational Research Bulletin*, Ohio State University, X (March 4, 1931), 115-118, 142.

A review of the different interpretations placed upon statistical significance with illustrative materials.

WALKER, HELEN M. "Democracy and Statistical Method," *Teachers College Record*, XXXII (April, 1931), 599-607.

The author explains the importance of statistics to democracy, and how it serves where human limitations make it impossible to extend personal observation to every member of the population, and where estimates must be based upon samples rather than upon the total population.

NEW TESTS

BRESLICH, E. R. *Breslich Algebra Survey Test*, Forms A and B. Bloomington, Illinois: Public School Publishing Company, 1931.

A survey test of diagnostic value to measure the pupil's actual working knowledge of algebra and of the practical applications of algebraic principles.

BRESLICH, E. R. *Breslich Geometry Survey Test*, Forms A and B. Bloomington, Illinois: Public School Publishing Company, 1931.

A series of tests designed to measure the pupil's ability to understand and to use intelligently the fundamental concepts of geometry, and other geometric abilities.

ENGLE, EDNA M., AND STENQUIST, JOHN L. *Engle-Stenquist Home Economics Test*. Yonkers-on-Hudson, New York: World Book Company, 1931.

A series of three objective tests relating to foods and cookery, clothing and textiles, and household management.

KELLEY, TRUMAN L., RUCH, GILES M., AND TERMAN, LEWIS M. *New Stanford Achievement Test*. Yonkers-on-Hudson, New York: World Book Company, 1931.

This is the fourth alternative form of the Stanford Achievement Test.

RESEARCH NEWS and COMMUNICATIONS

Address all research news and communications to Editor Carter V. Good, Teachers College, University of Cincinnati, Cincinnati, Ohio.

Research in Atlanta.—The Department of Testing and Guidance, or as it is sometimes called, Research and Guidance, was organized in 1917. The work of the Director of Testing and Guidance may be described, in general, as the giving of service. All parts of the school system from kindergarten through senior high school, including night and special schools, both white and colored, are served. In general, this service may be described as "educational accounting," a continuing study of pupil achievement in various school subjects.

The functions of this department, of which H. H. Bixler is director, are testing, research, guidance, and supervision.

In order to maintain high standards of achievement in the tool subjects, testing is conducted according to these principles:

1. Construct or select standardized tests for the various subjects in the course of study.
2. Administer the testing program by means of bulletins, conferences, teachers' meetings, etc.
3. Supervise the giving of standard tests.
4. Report and summarize the results of standard tests for superintendents, supervisors, principals, and teachers.
5. Make diagnoses of problem situations, such as the status of arithmetic throughout the elementary schools, or the reading achievement of a single school.
6. Suggest remedial measures to overcome weaknesses discovered.

The research program includes these activities:

1. Make the following statistical studies every year:
   a. Number and percent of non-promotions by schools and by grades.
   b. Number and percent of failures by departments in the high schools.
   c. Analysis of failures by contributing elementary schools, and by contributing junior high schools.
   d. Age-grade studies, *i.e.*, analysis of pupil progress through the grades.
2. Carry on special studies of best methods of teaching, for example, spelling; value of summer school instruction; etc.
3. Assist in curriculum research, that is, the study and revision of the curriculum in accordance with modern, scientific discoveries.

The guidance function is to:

1. Direct the guidance program by conferences, interviews with teachers and students, preparation of material, etc.
2. Coöperate with the Community Employment Service and with the business world by supplying ratings and other data on graduates and students withdrawing.

The department supervises teachers and activities as requested by the superintendents. Among the types of work already assigned are: accelerated classes in the junior high schools, selected high-school teachers who need help, and adjustment of the curriculum to meet the needs of special groups such as over-age and subnormal children.

The accomplishments of the testing program may be stated briefly. Objectively scorable tests, based upon the local curriculum, are constructed each year, according to modern methods of test construction. During the year, 1929-30, such standard tests were constructed or revised in the subjects of biology, business prac-

tice, vocational civics, English, English classics, French, Latin, library information, and spelling. These tests were mimeographed or printed on school presses. Such centralization of test construction is economical, since, in the absence of centralized printing, each school has to mimeograph its own tests with consequent increase of cost of stencils, etc. During the school year 1929-30 tests were administered in the school subjects of algebra, arithmetic, biology, business practice, vocational civics, English, home economics, Latin, reading, spelling, and writing. In all of these subjects many different tests were used to fit the needs of the various grades. As a result of the use of these measures there has been improvement in achievement in those subjects in which weaknesses were revealed.

Brief statements of the results of the program of research, guidance, and supervision may be made. The statistical studies provide the superintendents with accurate data concerning the functioning of the school system. The results of the guidance program include better adjustment of pupils, prevention of failure, and greater efficiency in school and business as a result of proper choice of courses. New teachers in the junior and senior high schools have been visited, suggestions have been made to each, and a written appraisal of the work of each teacher visited has been prepared for the superintendents.

Research in the Public Schools of Berkeley, California.—The Bureau of Research and Guidance of the Berkeley Public Schools was organized in 1919 by Virgil E. Dickson who is the present director. The staff consists of the director, an assistant director, one assistant, and a stenographer. The facilities with respect to office space and equipment are ample.

The chief function of the Bureau is the supervision of all child adjustment work. In the main this adjustment work is carried on through the organized plan of school counseling in elementary, junior, and senior high schools. Psychiatric service is available for difficult problems.

The major research projects at the present time are: (1) a study of children with behavior problems and (2) a study of gifted children. The first study is an attempt to demonstrate the effectiveness of procedures used in dealing with children presenting behavior difficulties by comparing the progress of a group of these children who are receiving help from physician, psychiatrist, and social worker with a second group who are receiving only the usual school counseling. The progress of the first group also will be compared with that of a group of normal children who were chosen to parallel the first in age, grade, and intelligence. This progress will be measured in several ways—by the opinions of psychiatrist and social worker, by detailed behavior rating scales filled out each semester by the classroom teacher and by standardized tests of school subjects. The survey to discover the most serious behavior problems was made in 1929. The study will be continued for five years from that date.

The second major project is the study of gifted children. This term is used in its widest sense to include not only the intellectually gifted but those children with marked ability in any field. In 1929 all teachers were asked to report those children who were especially gifted in any way. A similar survey was made in 1930 and 1931. A study will be made of every individual reported. Each child will be interviewed to discover his interests and plans for the future. In each

field where they are available standardized tests, such as the Seashore Measures of Musical Talent and the Meier-Seashore Art Judgment Test, will be given. An energetic attempt will be made to help these pupils in every way. Psychiatric service for those who are poorly adjusted socially will be available. Through the organized plan of school counseling any available opportunity for advanced work along the lines of the gift or talent will be recommended. These gifted pupils will be followed over a period of years to see if the talents persist.

Detroit Department of Research.—The Board of Education of Detroit holds as its basic principle the belief that all matters of policy and procedure may best be determined upon the basis of fact and evidence, rather than upon opinion. In order to assist in the collection and interpretation of all such evidence, the Department of Research was established in 1914. P. T. Rankin is the present director.

Since that time, the work of this department has continued along three main lines of activity: (1) the direct fact-finding activities of the department itself; (2) the coördination of the research activities of all members of the Detroit school system; and (3) assistance to those carrying on any type of research problem.

Each year the Department conducts one or more special studies in some field of educational effort. The Detroit individualization experiment, carried on in 1928-30 with thirteen schools and approximately 13,000 children participating, is the most extensive project yet undertaken. The results of this experiment are still in process of analysis. A study of the effect on educational achievement of glazing classrooms with special ultra-violet transmitting glass recently has been completed and similar studies are in process.

A regular achievement testing program, carried on at the beginning and at the end of each semester, furnishes information by means of which individual teachers and pupils are able to adjust their educational efforts to their needs. The tests included in this program are reading tests of both narrative and vocabulary type, fundamentals of arithmetic and arithmetic reasoning, grammatical forms and capitalization and punctuation aspects of English, spelling, art design, and handwriting. Other tests which are given in a more restricted range of grades are household mechanics, social science, composition, freehand lettering, nature study, and domestic science. Nearly five million copies of these tests are used each year.

The Department coöperates with supervisors of the various subjects in the construction of new forms of these tests at intervals sufficiently frequent so that no pupils take the same form of a test a second time. Although the testing program is voluntary and each teacher decides what tests she will give in her own classroom, the program as a whole is under the supervision of the Department of Research. Considerable time is spent in compiling the reports of the testing programs and in devising methods of interpretation which will make the scores on the tests as meaningful as possible.

Each year, in addition to the regular testing program, some one subject of the elementary curriculum is selected for special study. A battery of tests, composed partially of tests nationally used and partially of tests especially constructed to fit the local situation, is used. This battery is given throughout as wide a range of the school system as possible. The plan for these surveys calls for the

repetition of these tests at an interval of five or six years.

Committees of teachers, working in coöperation with members of the Department of Research, annually construct examinations in several different high-school subjects. These examinations are used at the option of the teachers as final examinations in the appropriate subjects for the following two semesters. To date, more than thirty such examinations have been constructed. Last year the subjects tested were Latin, world history, literature appreciation, health, and mathematics. In addition to their effect upon instruction in the particular courses for which they had been constructed, they have been of distinct value in offering to teachers illustrations of the objective examination methods which may be used in other subjects.

Each year the Department offers technical assistance to many teachers, administrators, and supervisors who are interested in carrying on experimental or research work in their fields of interest. Once each year an educational conference, conducted by the Department, provides an opportunity for the presentation of twenty or thirty reports of the outstanding examples of such experimental work completed during the year. The scope of these programs is such that all levels of activity in the school system are represented, and all groups become acquainted with the special efforts in the various fields of educational activity. Last year's program included, among other topics: "The Effect of Time Allotments on Achievement in Arithmetic," by a supervisor; "Is Teaching Success Predictable?" by a college professor; "What is a Well Balanced Library?" by a librarian; and "Using the Results of the English Survey," by a classroom teacher.

Denver Summer Meeting.—The fourth biennial convention of the World Federation of Education Associations will be held from July 27 to August 2. This organization came into existence in San Francisco in 1923. Succeeding meetings have been held at Edinburgh in 1925, Toronto in 1927, and Geneva in 1929. Teachers returning from the N. E. A. convention in Los Angeles are expected to stop in considerable numbers for the Denver meeting.

The Association includes departmental organizations as follows: the Parent-Teacher Association, health education, educational crafts, preparation of teachers, international aspects of library service, education and the press, rural life and rural education, pre-school and kindergarten, elementary education, secondary education, and the international aspect of colleges and universities. An exhibit of the work of school children of the various nations represented will be held in conjunction with the convention. Augustus O. Thomas, Augusta, Maine, is president and Charles H. Williams, University of Missouri, is secretary.

Summer Meetings of the A. A. A. S.—The American Association for the Advancement of Science from June 15-20 at Pasadena, California, is holding its first annual summer meeting of national character. Succeeding summer meetings will be at New Haven in 1932, Chicago in 1933, and San Francisco in 1934. Thomas Hunt Morgan is the retiring president and Franz Boas the newly elected president.

Research at Colorado State Teachers College.—The Department of Educational Research was organized in 1924 with Frederick L. Whitney in charge. The personnel of the research office consists of

the director and the research secretary working full time, a research fellow and assistant on half time, a student on half time acting as filing clerk, and as many trained student clerks each week as the activities of the office require. There is the usual equipment of calculating machines and a working research library.

At the time work was begun in the department, six major types of service activities were contemplated: (1) investigations for the administration, (2) studies for college committees, (3) professional and routine service to college instruction departments, (4) advice to graduate students, (5) coöperation with outside agencies, and (6) outside service.

Other illustrations of the types of projects the department is undertaking may be grouped under five headings as follows:

I. Administration
   1. Teacher Demand and Supply in the State
II. Curriculum
   1. Differentiation in the Content and Teaching Method of Teachers College Courses on Different Levels of Advancement
   2. The Relationship of Subject Matter Preparation to Actual Teaching Assignment under Contract
   3. Desirable Types of Offerings in Teachers College Subject-Matter Departments
   4. A Survey of Character Education in Teachers Colleges
   5. The Professional Preparation of Teachers of High-School Subjects
   6. The Personnel of Teachers-College Students
III. Finance
   1. Salary Schedules and Pay Rolls of the Faculty and Employees of the Teachers College
   2. The Economic Status of Teachers-College Faculties
   3. Unit Costs in the Teachers College
   4. Teachers-College Organization for Finance Administration
   5. Sources of Income for the Teachers Colleges
IV. Personnel
   1. A Study of Teachers-College Entrance Requirements
   2. The Total Load of Teachers-College Students
   3. The Relationship of Intelligence to Student Teaching and to Teaching Success under Contract
   4. Continuity Reports on the Scholastic Record of Campus Organizations
   5. Continuity Studies of Freshmen Classes
   6. Direct Individual Instruction in Desirable Teacher Traits
V. Teaching
   1. The Personnel of Class Enrollment in Teachers Colleges
   2. Class Size and Efficiency in Instruction in the State Teachers Colleges
   3. The Teacher-Training Service of the State Teachers College
   4. The Relative Efficiency of Instruction in Teachers College Resident and Extension Group Work
   5. Distribution of Teachers College Faculty Class Grades
   6. The Value of Student Judgments of Instructor Traits and Methods
   7. The Trinidad-Pueblo Class Size Experiment in the Primary School
   8. The Product of the College Teaching Departments

The titles of five research bulletins published since 1924 are:

1. Heilman, J. D. *Methods of Reporting the College Teacher's Load and Administrative Efficiency*, 1924.
2. Whitney, F. L. *The Social and Economic Background of State Teachers College Students*, 1925.
3. Whitney, F. L. *High School Opportunities in Colorado*, 1927.
4. Kelly, E. L. *Salaries in State Teacher Training Institutions*, 1928.
5. Whitney, F. L., and Condit, P. M. *Sources of Income for State Teachers Colleges and State Normal Schools*, 1929.

Special Education in Massachusetts.—Under date of January 1, 1931, the State

Department of Education reports a survey of special education for atypical children. The numbers of pupils in the various special schools and classes on this date were as follows: 8,332 three or more years mentally retarded (required); 2,827 backward (optional); 2,365 accelerated; 133 hospital; 280 receiving instruction in their homes from itinerant teachers; 1,550 fresh air, health, rest, and nutrition; 2,458 speech defects; 637 deaf; 1,039 hard-of-hearing; 213 adults in evening classes for hard-of-hearing; 169 blind; and 432 sight saving.

Reorganization at Rollins College.—The new curriculum plan to be put into operation at Rollins College with the opening of the college year, 1931-32, involves an upper and a lower division. New methods of evaluating student accomplishment have been evolved with the consequent abandonment of the present system of credits and grades.

The purpose of the lower division is to provide a place where the student may round out and fill in the gaps of his preparatory-school education as well as to provide a foundation for the more specialized work of the upper division. In the upper division the student's time will be occupied largely by intensive study in the field of his specialization. Rollins has become well known during the past few years because of its laboratory or workshop two-hour plan of teaching.

Annual Report of the Commonwealth Fund, 1930.—The year 1929, in the work of the Commonwealth Fund, was one of outstanding change in field operations. The Austrian program was completed. The child health demonstrations were wound up. A new public health program was adopted. A child guidance clinic was opened in London. By contrast, the year 1930 has been one of transition, intensive development of old and new enterprises, and revaluation of underlying principles. The new health program has been launched. No new hospitals have been built, but the experience of those already at work has been reviewed with an eye to future extensions of the program. Certain phases of medical education have come to play a central part in both these fields. In mental hygiene much thought has been given to training, for it is increasingly clear that the future of the child guidance clinics rests on too narrow a base of psychiatric education. Outside its own programs, the Fund has broadened its contact with fundamental research of a sort which promises to enrich preventive medicine.

The broad outlines of the work have not altered. The appropriations of the past year group themselves as usual around three major centers of interest: public health, mental hygiene, and British-American relations. Taking account both of the special projects of the Fund and the grants which it makes to other agencies, public health, preventive medicine, and medical research absorbed 38 percent of the total appropriations; mental hygiene, 30 percent; the Commonwealth Fund Fellowships for British students, 15 percent; legal research, 5 percent; and other fields of work, 12 percent.

The Commonwealth Fund Fellowships have been maintained without important change. Including the appointees of the present year, 147 men and women have now been given the opportunity to study in this country. Interest in the Service Fellowships, designed for men actively employed in government service overseas, has been so great that the number of awards available in this group has been increased. Reports from the Fellows in

residence show that they approach American life with open-minded curiosity and a ready warmth of appreciation for unfamiliar institutions and characteristics.

The attention of the new Division of Public Health, organized at the beginning of 1930, has been centered during the year on the inauguration of the new state program for rural health in Tennessee. The selection of Massachusetts as a second state for similar development brings the Fund once more into contact with the fine local traditions of self-help which are characteristic of New England, and which have already been evident in connection with the hospital at Farmington, Maine.

The Fund has withdrawn from the visiting teacher project after eight years' support of the National Committee on Visiting Teachers. The rapid spread of visiting teacher work and the establishment of standards of training during this period lead to the belief that this very useful form of service in schools has won a permanent place in the American educational system. There were no other changes of moment in the Fund's mental hygiene program: the Institute continued its training activities, contributing psychiatrists, psychologists, and psychiatric social workers to the child guidance field; and the Division on Community Clinics of the National Committee for Mental Hygiene maintained its advisory service through a year of somewhat difficult adjustments among the child guidance agencies.

In Great Britain the London Child Guidance Clinic has functioned successfully for more than a year and has commended itself not only to educational and social agencies but to the general public, so that a considerable number of children are brought to it by their own parents. In sound and conservative fashion, the Child Guidance Council has stimulated the adoption of child guidance principles and of psychiatric social work at a number of points in the field of mental hygiene. The efficiency of both organizations will, it is expected, be increased by the recent decision to separate the Clinic from the Council.

The Legal Research Committee has continued to sponsor a series of studies in administrative law.

With the publication of seven new books, the Division of Publications has carried forward its task of interpreting the work of the Fund for a wider audience than can be reached directly by operations in the field.

The Statistical Service, formerly combined for administrative convenience with the Division of Publications, was established as a separate department during the year. Work with the child guidance clinics has been continued; nineteen clinics are sending their current reports to the Fund for comparison and tabulation, and twenty-seven are using either part or all of the record system developed by the statistician. Careful study has been made of the statistical requirements of the new public health program and the rural hospitals.

General Education Board, 1929-30.—The annual report for 1929-30 describes the activities and contributions of the Board in a variety of fields: colleges and universities (humanities, sciences, methods of teaching and the curriculum, and administration and personnel); public education (state departments of education, studies, fellowships, conference, and training of teachers); negro education (colleges and universities, medical education and nurse training, junior colleges, normal and industrial schools, state controlled institutions, state agents for negro rural schools, fellowships, John F. Slater Fund, and Anna T. Jeanes Foundation); medical education; and industrial art.

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